Australasian Plant Conservation

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The impacts of increasing solar ultraviolet light on the wetland mires of the mainland Australian Alps

Reversing drivers of degradation in Blue Mountains and Newnes Plateau Shrub Swamp endangered ecological communities

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And much much more …

SPECIAL THEME: WETLANDS AND PLANT CONSERVATION

ANPC National Office

GPO Box 1777
Canberra, ACT 2601, Australia
Ph: (02) 6250 9509
Fax: (02) 6250 9528
Email: anpc@anpc.asn.au
Web: http://www.anpc.asn.au

National Office Staff
Sue Mathams and Merryl Bradley

Volunteers
Odette Mayne

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Editor
Rosemary Purdie

Editorial Team
Paul Gibson-Roy, Sally Jacka, Bob Makinson, Sue Mathams and Zoë Smith

Layout & Graphic Design
Siobhan Duffy

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President Philippa Crisp
Secretary John Sawyer
PO Box 5086 Wellington, New Zealand.
Email: info@nzpcn.org.nz
Web: www.nzpcn.org.nz

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"To promote and improve plant conservation"

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Australasian Plant Conservation is a forum for information exchange for all those involved in plant conservation: please use it to share your work with others. Articles, information snippets, details of new publications or research, and diary dates are welcome. **The deadline for the June–August 2010 issue is Friday 28 May 2010.** The theme of that issue will be **'Regrowth: a positive force for plant conservation'.** General articles are also very welcome. Please contact Tom Celebrezze if you are intending to submit an article: tom.celebrezze@environment.nsw.gov.au.

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Front cover: Buttongrass (*Gymnoschoenus sphaerocephalus*) wetland, Ebor, New England Tablelands with abundant yellow *Xyris operculata*. Photo: Adam Gosling.

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From the Editor

Rosemary Purdie

c/- Centre for Plant Biodiversity Research, Canberra.

The theme for this issue of *Australasian Plant Conservation* is 'Wetlands and plant conservation'. As many ANPC members in southern Australia would know, numerous wetlands there have been decidedly dry over the recent years of drought, with those conditions adding to the challenges of managing these important ecosystems. Climate change, urban and other development, weed invasion, feral animals, clearing of surrounding landscapes in catchments, inappropriate management (including fire and grazing regimes), inappropriate recreational activities, drainage and river regulation are among the numerous threats being tackled. Desired management outcomes include maintaining or restoring wetland ecosystems, increasing wetland resilience, and conserving wetland-dependent plant (and animal) species.

For this issue, we defined wetlands as natural areas that are periodically or permanently inundated, as well as constructed wetlands. All types are covered in the following articles.

We start with wetlands in upland areas, looking at plant conservation work associated with wetlands in the Alps National Parks, the Blue Mountains and Newnes Plateau and on the New England Tablelands of New South Wales. These articles are followed by two on wetlands associated with major river systems—a variety of wetlands on the Murray-Darling system, and billabong wetlands of the Yarra River in Victoria. We then turn to plant conservation work in drier systems—claypan wetlands of Drummond Nature Reserve north-east of Perth, Western Australia, and the Lake Bathurst and The Morass wetland system near Goulburn in New South Wales.

Our attention then turn to tackling specific weeds of wetland ecosystems: Common Reed (*Phragmites australis*) in Chesapeake Bay, USA; Devils Claw (*Martynia annua*) along rivers in Gregory National Park in the Northern Territory (where getting rid of the weed has been turned into a festival); and Cat's Claw Creeper (*Macfadyena unguis-cati*) and Salvinia (*Salvinia molesta*) in the Richmond Catchment in northern New South Wales.

In the final three wetland articles, we look at the educational opportunities provided at the Adelaide Botanic Gardens through a wetland to be constructed for water storage and recovery, and the activities and resources available through two non-government organisations set up to focus on wetland conservation—WetlandCare Australia, and the newer Murray Darling Wetlands Ltd.

Before our regular items, there is an update on research from the wheatbelt of Western Australia looking at the conservation value of fencing remnant woodlands, an article from Nigeria outlining medicinal plants under threat in that country's northern savannah areas, and the third report on ANPC in the USA. These are followed by the Report from the New Zealand Plant Conservation Network, Research Roundup, three book reviews, Information Resources, and Conferences and Workshops.

It's an issue full of interest, so read on!

The Morass, a wetland on the Southern Tablelands of New South Wales that until recently had been dry due to drought conditions, is part of an area undergoing plant rehabilitation work described in the article on pages 15 and 16 of this issue. Photo: R. Purdie.

The impacts of increasing solar ultraviolet light on the wetland mires of the mainland Australian Alps

Roger Good[1], Genevieve Wright[2], Geoff Hope[3] and Jennie Whinam[4]

[1]1178 Bungendore Road, Bungendore NSW. Email: rgo03227@bigpond.net.au

[2]NSW Dept of Environment, Climate Change and Water, Queanbeyan, NSW.

[3]Archaeology and Natural History, Australian National University, Canberra.

[4]Biodiversity Conservation Branch, Dept of Primary Industries and Water Tasmania, Hobart.

Introduction

The wetland mires of the Australian Alps were listed in 2009 as a nationally threatened ecological community (*Alpine Sphagnum Bogs and Associated Fens*) under the *Environment Protection and Biodiversity Conservation Act 1999*. This was because the area of bogs and fens has declined dramatically over the past 150 years due to grazing by domestic stock, recreation activities, infrastructure development, increasing feral animal damage and exotic weed invasion.

The bog and fen communities are widespread across the Alps with the majority of them being within the Alps National Parks. Within these parks the area of bogs and fens has declined from approximately 8500 ha pre-European settlement, to currently about 5000 ha in reasonable condition. Although many bogs and fens in the parks had recovered from past grazing impacts, the high intensity wildfires of 2003 and 2009 had a considerable adverse impact on them. Approximately 70 bogs required restoration works after the 2003 wildfires to ensure they recovered to a fully functional condition.

Climate change and changes in local climatic conditions are now the greatest threat to the survival of the bogs and fens. The predicted climate change scenarios for the Alps indicate higher temperatures, less snow and more precipitation as high intensity storm events. Already experiencing changes in precipitation regimes, increased summer temperatures, lower total cloud cover and elevated ultraviolet light levels, the Alps ecosystems have been identified in the National Climate Change Adaptation Framework (COAG 2006) as being critically vulnerable to the detrimental impacts of climate change.

Increases in solar ultraviolet radiation (UVR) is predicted to have a significant impact on bog plants, particularly *Sphagnum* (moss) species. Although solar UVR occurs as long-wavelength UV-A, short-wavelength UV-C and medium wavelength UV-B, only UV–B is significant in terms of impacts on biological systems.

Over the past decade annual total solar UV-B exposure levels have increased in the Australian Alps (Good, unpublished data) by approximately 12 per cent, partly as a response to the increased number of cloud free days but possibly as a response to the influence of atmospheric ozone depletion.

Impacts of solar UV-B increases on alpine biota

Little research has been done to identify the impacts of UVR on mire vegetation, particularly in alpine areas. Several studies in the northern hemisphere have identified amphibian populations, particularly frogs, as decreasing rapidly over recent years and identified links between these declines and increasing UV-B levels (Blaustein *et al.* 1994). In the Australian Alps, UV-B affects the Alpine Tree Frog (*Litoria verreauxii alpina*) and possibly the Corroboree Frog (*Pseudophryne corroboree* and *P. pengilleyi*), and may cause populations of these and other frog species to decline drastically with possible local extinctions at higher elevations (Broomhall 1998).

Impacts of increasing solar UV-B on Sphagnum bogs and fens

The bog communities are edaphic groundwater communities, essentially maintained by snowmelt and summer runoff, as well as subsurface seepage. The bogs are characterised by *Sphagnum cristatum, Empodisma minus* and *Epacris paludosa.* The *Sphagnum* often occurs as large hummocks growing over small shrubs. In sites that are not suitable for shrub growth, *Sphagnum* grows with *Carex gaudichaudiana*. In continuously wet sites where water-ponding occurs, acid fens colonised almost entirely by *Carex gaudichaudiana* are present.

The bogs and fens with free-standing surface water are predicted to be most affected by increasing UV-B, as ultraviolet light can penetrate to considerable depths in near-pristine alpine ponds (Smith 1989). Where there has been little disturbance of the bogs and fens, the pond-fringing herbaceous vegetation is shaded from UV-B by the taller herbs (*Empodisma minus, Baloskion australe*) and in many sites by shrubs (*Epacris paludosa*, *Melaleuca pityoides and Richea continentis)*. Unfortunately in the majority of bog and fen sites the fringing shrub vegetation has been lost due to past grazing and recent burning. As a result many bogs and fens have very much reduced

natural shading of the significant remnant *Sphagnum* and the populations of frogs and invertebrate decomposers that inhabit the moss and ponds.

It has been recognised that *Sphagnum* species grow most readily where approximately 70 per cent shade cover is provided by other shrubs and tall grasses (Hope *et al.* 2005). With the loss of the natural shade cover as a response to climate change factors, the extent and distribution of *Sphagnum* in and around bogs and fens will continue to decline as UV-B levels increase.

Using shadecloth to ameliorate impacts

After the 2003 fires in Namadgi and Kosciuszko national parks, 70% nylon shadecloth was spread over a number of bogs (Figure 1) to ameliorate the impact of UV-B on the remnant *Sphagnum* hummocks and to promote *Sphagnum* recovery (Good 2008). This adaptive management response has to date been very successful (Dave Whitfield *pers. comm..,* Namadgi National Park) in both assisting the regrowth of *Sphagnum* and of other bog plants, particularly *Empodisma* spp.

Shadecloth has also been found to be beneficial for total biomass production. From the data derived from quadrats established to monitor *Sphagnum* recovery, after five years it was found that biomass production under the shadecloth was approximately 30 per cent higher than the biomass production for the adjacent unshaded quadrats (Figure 2). The annual total mean biomass production was 4.35 tonnes per hectare for the unshaded sites and 6.02 tonnes per hectare for shaded sites.

Summary

Changes in precipitation and runoff flow regimes from climate change may adversely impact the hydrological functioning of the alpine bogs and fens. However the high and increasing levels of solar radiation as ultraviolet light UV-B will be just as significant as it will influence the resilience, survival and distribution of the water dependent vegetation species (particularly *Sphagnum*) and amphibians (such as Corroboree Frogs) and invertebrates dependent upon the *Sphagnum* for their breeding and survival.

Irrespective of the restoration efforts of field managers to date to protect many bog and fen sites, further loss of these organic groundwater communities seems inevitable, as it is predicted that over the next 50 years the total area of mire will further decline from approximately 5000 ha to about 3900 ha of stable, fully functional bog and fen. The long-term prospect is however closely tied to the scenarios for climate change, currently reported as tracking the most extreme predictions by the International Panel on Climate Change.

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Figure 1. Shadecloth spread over a degraded bog to protect and enhance the regrowth of remnant Sphagnum *hummocks. Photo: D. Whitfield.*

Figure 2. Shadecloth removed showing the regrowth and biomass production of Empodisma *and* Sphagnum *species. Photo: D. Whitfield.*

Reversing drivers of degradation in Blue Mountains and Newnes Plateau Shrub Swamp endangered ecological communities

Michael Hensen and Eric Mahony

Blue Mountains City Council, Katoomba, NSW. Email: mhensen@bmcc.nsw.gov.au

The 'Save our Swamps' (SOS) project is an integrated program of works to protect and enhance the condition and extent of the nationally endangered 'Temperate Highland Peat Swamps on Sandstone' across the Blue Mountains and Lithgow local government areas. It is funded by both the NSW Environmental Trust and Commonwealth 'Caring for Country' program.

The SOS program has adopted an ecosystem restoration approach. This focuses on rehydrating desiccated swamp systems to restore their natural hydrological conditions, thereby allowing natural swamp regeneration to occur, while concurrently 'turning the tap down' on ongoing drivers of swamp degradation within their catchments.

The Blue Mountains swamp rehabilitation works are supported by soft engineering structures and conventional soil conservation earthworks in the surrounding catchment. These encourage the diversion, detention and infiltration of sediment laden stormwater runoff before it can reach the affected swamp systems to protect them from ongoing erosion and sedimentation. In the Newnes Plateau Shrub Swamps this approach is complemented with additional measures for controlling threats from recreational vehicles.

Context of the project

The 'Temperate Highland Peat Swamps on Sandstone' endangered ecological community is characterized by the formation of highly organic 'peaty' waterlogged soils overlying sandstone substrates at altitude. The swamps are found in the poorly drained headwaters and gently sloping valleys of the Blue Mountains and Newnes Plateaus as well as in the Southern Highlands and around Bombala. Under the *Threatened Species Conservation Act 1995* (NSW) they are also listed as threatened under their regional variations, including Blue Mountains Swamps, Newnes Plateau Shrub Swamps and Montane Temperate Peatlands.

These swamps provide vital ecosystem services by acting like giant sponges in the landscape absorbing and filtering water before releasing it slowly back to the environment. They help to maintain baseflows to watercourses, moderate peak flow events and purify water by filtering out sediments and pollutants. They also provide habitat for several nationally endangered animal species including the Blue Mountains Water Skink and Giant Dragonfly, and many threatened or regionally significant plants including *Carex klaphakei*, *Lepidosperma evansianum*, *Almalaea incurvata* and *Boronia deanei*.

Approximately 3200 ha of Blue Mountains Swamps exist with over 1000 ha within catchments impacted by the urban ridgeline development characteristic of the Blue Mountains townships. Urban development has resulted in an increase in impervious surfaces, peak flow volume and duration, causing a reduction of recharge to aquifers that support ground water dependent ecosystems; erosion, gullying, piping and channelisation within swamps; and delivery of sediment containing nutrients and weed propagules.

Incised channels or pipes drain subsurface flows, lowering groundwater tables within swamps and desiccating swamp substrates. Desiccation causes a significant reduction in floristic complexity and makes affected swamps vulnerable to weed invasion. Weeds are able to exploit the openings created by weakened or dying swamp plants, and thrive on the more aerobic but still relatively moist and nutrient rich soil conditions.

Approximately 650 ha of Newnes Plateau Shrub Swamp occur on the Newnes Plateau, of which only 160 ha are protected in the conservation estate. A significant driver of degradation is recreational vehicles that damage swamp systems as well as creating highly erosive access trails which dump significant amounts of sediment into swamps, smothering their vegetation.

In 2005, the Blue Mountains City Council's Upland Swamp Rehabilitation Program began to trial, modify, and adapt the soft engineering swamp rehabilitation techniques pioneered in the bogs and fens of Kosciuszko National Park (Good 2006) to the local context and conditions of Blue Mountains Swamps. The SOS program has continued the ongoing process of adaption and refinement of these techniques for Temperate Highland Peat Swamps across almost their entire range.

Methods and outcomes

The principle strategy behind soft engineering swamp rehabilitation is to slow the movement of water through swamps by constructing check dams, water spreaders and chains of infiltration cells to encourage the lateral and vertical rehydration of desiccated swamp substrates. Simultaneously, ongoing drainage and dewatering of swamp substrates is prevented by packing and infill of drainage points such as areas of channelisation and piping.

The soft-engineering swamp rehabilitation techniques used in the project utilise predominantly organic materials such

as coir logs, sterilised straw bales, jute mesh, jute matting and wooden stakes. Over time these organic materials break down and become incorporated into the swamp substrate.

This is complemented by the installation of devices in the swamp's immediate catchment to mitigate the causal stormwater drivers of degradation. Devices include:

- soft engineering structures designed for spreading and holding water below stormwater outlets to reduce stormwater erosivity and encourage infiltration; and
- soil conservation works such as roll-over bars, mitre drains, detention basins, ripping, brush matting and revegetation to control erosion and encourage infiltration along access trails and hardened degraded areas within the swamp catchment.

In the Newnes Plateau additional strategies have been developed to address the impacts of recreational vehicles in swamps. These include:

- strategic restriction of vehicular access with bollards, brush-matting, 4WD barrier pits and track closures;
- the provision of sacrificial single track crossings where alternative diversions are not available; and
- educational presentations to 4WD and trail bike clubs to raise awareness of the ecological values of swamp systems and their sensitivity to damage.

Infiltration cells rehydrate swamp areas degraded by recreational vehicle damage, Newnes Plateau. Photo: Michael Hensen.

Skills being transferred to relevant land manager staff during a workshop. Photo: Michael Hensen

Benefits

The SOS approach to swamp rehabilitation has demonstrated multiple benefits. It directs resources to treating the causes rather than the symptoms of degradation, thereby avoiding the unnecessary diversion of resources into open-ended weed control programs, which will tend to occur where drivers of degradation are still operating in swamp systems. Once the swampy waterlogged and anaerobic conditions are re-established by the soft engineering rehabilitation techniques, many weeds (particularly weedy grasses) are outcompeted by the spontaneous natural regeneration of native swamp vegetation and no longer require the same level of control.

The approach also encourages a whole-of-catchment approach and helps prioritise resources to situations where the drivers of degradation can be reversed or substantially mitigated, leading to long-term sustainable rehabilitation outcomes.

Building community capacity

The program of on-ground rehabilitation works are complemented by community capacity building initiatives including:

- a community education and awareness raising program;
- a school education program aiming to incorporate swamp wetland education into the curriculums of primary and secondary schools in the Blue Mountains and Lithgow local government areas;
- a community Swampcare volunteer program consisting of a mixture of capacity building workshops and on-ground volunteering opportunities;
- a private landholder incentive program to encourage private landholders in priority sub-catchments to protect and enhance swamp communities on private property; and
- a workshop program to transfer soft engineering swamp rehabilitation skills to relevant agency staff and land managers.

Swamp remediation manual

The knowledge gained through the SOS program, including case studies and technical specifications for implementing soft engineering swamp rehabilitation techniques, are currently being compiled into a swamp remediation manual by E.Mahony and M.Hensen. Titled *Soft engineering solutions for swamp remediation — A 'How to' guide*, it will be available from the SOS website <www.saveourswamps.com> from mid April 2010.

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Conserving the endangered montane wetlands of the New England Tablelands

Adam Gosling and Nic Cobcroft

WetlandCare Australia, Ballina, NSW. Email: adamgosling@wetlandcare.com.au

Ranging from shallow, ephemeral lagoons amongst open, grassy woodlands to peat swamps at the icy headwaters of mountain creeks, the montane wetlands of the New England Tablelands of New South Wales are both intrinsically beautiful and incredibly biodiverse. They support a unique variety of flora and fauna, many of which are endemic and have an extremely limited distribution.

Most of the wetlands occur in a highly modified agricultural landscape, and as a consequence many have suffered significant damage or have been completely lost. A large percentage of those wetlands remaining are located on private property and are critically important as they provide the only habitat for a range of interdependent species. Amongst these species are many that are rare or threatened including the migratory Latham's Snipe *(Gallinago hardwickii)*, the ground burrowing Sphagnum Frog *(Philoria spagnicolus)*, the Giant Dragonfly *(Petalura gigantea)*, the New England Gentian *(Gentiana wissmannii)* and the endangered Tenterfield Eyebright *(Euphrasia orthocheila)*.

These montane wetlands are also located within the only Australian north–south corridor that can support conservation linkages over the maximum possible elevation, latitude and climate range. Additionally, many of these wetlands are at the headwaters of creeks and drainage lines which provide drinking water for the majority of the population of the east coast of Australia.

'Upland Wetlands and Montane Peatlands and Swamps of the New England Tableland' are listed as endangered ecological communities under the *Threatened Species Conservation Act 1995* (NSW). Upland wetlands are also nationally listed as endangered under the *Environment Protection and Biodiversity Conservation Act 1999*. These listings recognise these wetlands' significance and vulnerability and provide legislative mechanisms to aid their protection. Unfortunately, these listings do not alone ensure wetland conservation.

Over the past six years, WetlandCare Australia has been working with landholders, researchers, government agencies, Landcare groups and passionate individuals on projects that have resulted in the protection and enhancement of over 2500 hectares of these wetlands and their immediate upper catchments. With funding from the New South Wales and Federal Governments, Northern Rivers Catchment Management Authority and the Border Rivers-Gwydir Catchment Management Authority, WetlandCare Australia has delivered a variety of on-ground works including wetland protection fencing, weed and feral animal control, revegetation of buffer zones and installation of interpretive signage. Numerous community field days have also been held in order to showcase the work that has been achieved, and to raise awareness of these important ecosystems and the need to further protect them.

Upland wetlands field day at Little Llangothlin. Photo: Adam Gosling.

Upland wetlands (lagoons)

Upland wetlands or lagoons occur as permanent, intermittent or ephemeral wetlands in oval-shaped depressions above 900 meters elevation. The majority have suffered extreme modification with more than 70 per cent having been drained or dammed. Most lagoons hold water only temporarily and ecological communities have adapted to take advantage of this natural cycle of wetting and drying. Hydrological alterations, accumulation of sediment, weed infestation, ecological damage by feral pest species and continued clearing are some of the historical and current, threats to these wetlands. Healthy lagoons of this kind are extremely rare on the New England Tablelands to the extent that only about 15 of the documented 58 remain in a reasonable condition.

Like other high altitude ecosystems with a restricted distribution, upland lagoons are threatened by the effects of anthropogenic climate change. The predicted increase in temperature and reduction of precipitation are likely to render these wetlands even more vulnerable to factors such as weed and feral animal invasion, as well as having a significant impact on the distribution and health of the remaining lagoons.

Plants found in wetlands at Ebor: Xyris operculata *(left),* Thysanotus tuberosus *(centre) and* Thelymitra cyanea *(right).*
Photos: Adam Gosling.

WetlandCare Australia has facilitated the rehabilitation and protection of five of the most intact upland lagoons through long-term conservation agreements. These include iconic lagoons such as Dangars, Racecourse, Barleyfields and Thomas, all located near Uralla, and a second Barleyfields lagoon at Glencoe. All these sites now have long-term management agreements in place, and the land managers have the resources to undertake the requisite actions to ensure that the wetland's ecological health is maintained into the future.

Montane peatlands and swamps

Montane peatlands and swamps are found at the headwaters of high altitude creeks where the topography is relatively flat and runoff is slow. This allows the accumulation of peaty or organic sediments which favour these unique vegetation communities. Common plant families represented include Poaceae, Cyperaceae, Myrtaceae and Fabaceae, which combine to form vibrant and colourful wetlands in the hidden corners of the New England Tablelands. Their composition is highly variable and differs according to substrate, water flow and historical anthropogenic pressures (including overgrazing, clearing, draining, nutrient enrichment and high fire frequency). Over-exposure to some, or all, of these can ultimately result in the destruction of seed banks and the death of these vegetation communities.

Like the upland lagoons, the health and diversity of these ecosystems are also threatened by the likely effects of climate change. Increased temperature and decreased precipitation will result in both a contraction of the species distributions, increased susceptibility to weed and feral animal invasion and higher fire frequencies. Like many high elevation plant communities, there are restricted opportunities for altitudinal succession.

WetlandCare Australia has provided funding to promote the importance and facilitate the rehabilitation and protection of these fascinating wetlands. Through numerous stages of WetlandCare Australia's endangered ecological community montane wetland projects, and with current Federal funding, landholders have been assisted to properly manage these wetlands. In addition, the wider community has been provided with extension services and education opportunities through information dissemination and field days, improving the understanding and capacity of landholders to better manage these wetlands.

Future work

Due to the significance and limited distribution of the endangered montane wetlands of the New England Tablelands, they remain a high protection priority for WetlandCare Australia under the organisation's 'Australian Wetland Biodiversity Program'. This program focuses on the protection of nationally- and state-listed threatened species, endangered ecological communities and high conservation value aquatic ecosystems.

With impending climate change, this work is imperative to enhance the resilience of important ecosystems such as montane wetlands. WetlandCare Australia continues to work closely with landowners and other agencies in many areas to restore wetlands and protect their dependant flora and fauna.

WetlandCare Australia's experience in working on the New England Tablelands in partnership with local stakeholders has delivered exceptional immediate and future environmental benefits. In addition, the experience has also highlighted the value landowners now place on these wetlands and their desire to assist in long-term environmental preservation. It is now widely accepted that these wetlands not only have considerable environmental value, but also play a vital role in overall landscape health and the resulting agricultural benefits. Traditionally, funding available for environmental works has probably exceeded demand; this is no longer the case.

WetlandCare Australia's mission 'to support the community to protect and restore Australian wetlands', has resulted in protection of 2500 hectares of these wetlands and their immediate upper catchments. The work undertaken will ensure the existence of these unique montane wetland ecosystems for future generations to discover, appreciate and treasure.

Wetlands of the Murray-Darling Basin: EPBC Act threatened ecological communities?

Gina Newton

Department of the Environment, Water, Heritage & the Arts, Canberra. Email: gina.newton@environment.gov.au

Under the EPBC Act

Areas of significant wetlands form part of two aquatic ecosystems currently being assessed for listing as threatened ecological communities under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). The aquatic ecosystems are the Lower Murray–Darling to Sea and the Wetlands of the Darling Basin. Listing would confer national conservation benefits, including an increased public awareness for these highly productive, biodiverse environments. The EPBC Act focuses on nationally significant aspects of the environment and provides for the identification and protection of matters of National Environmental Significance. Nationally threatened species and ecological communities are one of several such matters.

The listing process for threatened ecological communities begins with the receipt of nominations from the public. These are strategically assessed by the advisory Threatened Species Scientific Committee for suitability and a Proposed Priority Assessment List is forwarded to the Environment Minister for approval each year. Based on the Minister's determination, this list then becomes the Finalised Priority Assessment List.

For assessment of the ecological communities on the finalised list, the Department relies heavily on input and data from experts, including those from State/Territory agencies. Expert consultation also generally includes holding a technical workshop. More information on the process is available at <www.environment.gov.au/biodiversity/threatened/index.html>.

A first for riverine wetlands

The Lower Murray–Darling to Sea was originally nominated in 2007 as the Coorong and Lower Lakes. This was expanded and included on the August 2008 Finalised Priority Assessment List as *The Lower Murray River and associated wetlands, floodplains and groundwater systems from the junction of the Darling to the sea*. This fitted well with the Minister's nomination conservation theme for that year of 'rivers, wetlands and groundwater dependent species and ecosystems of inland Australia'.

The advisory committee agreed that there was greater conservation benefit in expanding from the Coorong and Lower Lakes (already Ramsar listed and thus a matter of National Environmental Significance) to include the region of upstream influence and impacts, as well as the interdependent groundwater, floodplain and wetland components. The region is considered by experts to be a 'one of a kind' system in the national context, and different from other river systems (and the parent rivers) due to its complex features, habitat heterogeneity, and high levels of biodiversity over relatively short distances. The region also has special significance to Indigenous peoples.

Subsequent to the Lower Murray–Darling to Sea assessment, another major wetland focussed ecological community was included on the 2009 Finalised Priority Assessment List, viz. *The Wetlands of the Darling Basin* (nominated as Macquarie Marshes). This wetland system was frequently flooded prior to regulation and supports (or supported) large breeding events by colonial water birds. Once described, the ecological community is likely to include the terminal wetland systems of the Macquarie Marshes (some 200 000 ha), Narran Lakes (some 30 000 ha) and the Gwydir (formerly one of the most significant semi-permanent wetlands in north-west New South Wales, some 100 000 ha). These wetlands also support a diverse flora, with many species at the edge of their range, as well as very diverse avian and reptilian faunas.

The Lower Murray–Darling to Sea and Wetlands of the Darling Basin ecological communities cover the range of wetland types and forms, from saline to fresh, ephemeral to semi-permanent, and billabongs and lakes to braided channels. All are defined by what's often considered the so-called 'maestro' variable in Australia's riverine ecosystems—flow, with its associated cycles and flooding regimes.

A new aquatic challenge

The Lower Murray–Darling to Sea is unique in that it represents the first riverine system to be assessed under the EPBC Act as a threatened ecological community. A major challenge for this assessment is that the listing assessment criteria were initially developed for terrestrial vegetation-based systems. To be listed under the EPBC Act, at least one of six criteria contained in the *EPBC Regulations 2000* must be met. The criteria determine whether an ecological community is eligible to be listed and under which category (i.e. critically endangered, endangered, or vulnerable).

The applicability of the listing criteria to aquatic systems in general, and the Lower Murray–Darling to Sea was specifically discussed as part of the expert technical workshop held for this assessment process in July 2009.

The workshop found that the listing criteria are generally applicable but may need nuancing when applied to aquatic systems. The workshop determined that the 'ecological community' of a large complex aquatic system often consists of sub-units of different biophysical complexity. For example, while the Lower Murray–Darling to Sea ecological community may be considered as a 'constructed' system (i.e. comprised of several smaller ecological communities), its components are functionally connected. Thus, criteria should still be applied at the whole system level, not at the sub-unit level.

The high variability of aquatic systems—temporal, spatial, natural and anthropogenic—combined with the interplay of surface and ground waters, compounds the challenge and requires consideration and some degree of flexibility with respect to interpretation of the listing criteria and their concomitant 'thresholds'. It was considered essential that a quality 'baseline' (or benchmark state) be determined, keystone or foundation species identified, and key indicators of decline (as related to threats) established.

Importantly for wetlands and their associated floodplains, it was recognised that the assessment should take into account the fact that these component-systems can transition between aquatic (wet) and terrestrial (dry) states.

National importance and conservation benefit

Both the Lower Murray–Darling to Sea and Wetlands of the Darling Basin ecological communities include several Ramsar listed wetlands. The former community includes the Coorong and Lakes Alexandrina and Albert, Riverland (including the Chowilla floodplain), and Banrock Station Wetland Complex. The latter community includes the Macquarie Marshes, Gwydir and Narran Lake Nature Reserve.

Australia currently has 65 Ramsar wetlands that cover around 7.5 million hectares. Ramsar wetlands are those that are representative, rare or unique wetlands, or are important for conserving biological diversity. These are included on the *List of Wetlands of International Importance* held under the Ramsar Convention.

Australia also has more than 900 'nationally important wetlands' (as based on meeting one of six criteria). These are wetlands that are a good example in a particular area, an important habitat for native species, or that have outstanding heritage or cultural significance. Nationally important wetlands are listed on the *Directory of Important Wetlands* (see www.environment.gov.au/water/topics/wetlands/database/diwa.html).

While Ramsar listing of wetlands affords conservation benefit, inclusion of these wetland systems within an overarching threatened ecological community offers complementary conservation benefit beyond the sites, including connectivity to other system elements such as important upstream influences. A threatened ecological community listing can also provide broader national conservation benefit spatially, for example only approximately nine per cent of the Macquarie Marshes is currently Ramsar listed.

Next steps

The assessments for the Lower Murray–Darling to Sea and Wetlands of the Darling Basin wetland communities will take up to three years, with the former due by September 2011 and the latter by September 2012. The assessment process will include public and targeted consultation to assist with the determination of listing eligibility.

The technical workshop report for the Lower Murray–Darling to Sea is scheduled to be available for public comment on the Department's website by April 2010. The assessment process for the Wetlands of the Darling Basin has just commenced and a technical workshop is planned for late 2010. Another technical workshop, focussing on thresholds associated with the listing criteria and 'condition' as they relate to complex aquatic systems and the Lower Murray–Darling to Sea is planned for April 2010.

Two wetland areas of the Lower Murray–Darling to Sea ecological community.
Photos: SA Murray Darling Basin NRM Board.

Vegetation management and hydrological restoration of Bolin Bolin Billabong, Victoria

Karl Just[1] and Garry French[2]

[1]Yarra Braes Road, Eltham, Vic. Email: karljust10@hotmail.com

[2]Parks Victoria, Templestowe, Vic.

Background

Billabong wetlands comprise some of the most endangered ecosystems in Victoria. Damming and regulation of most major river systems has greatly reduced the capacity of lowland streams to flood onto adjacent plains, often leaving billabongs stranded and dry. Unless more focus is given to these highly significant icons, they are likely to become increasingly degraded and modified over time.

Bolin Bolin Billabong is a wetland situated in the middle Yarra floodplain at Bulleen, approximately 10 km north-east of Melbourne. The billabong is of high cultural significance to the Wurundjeri people, who formerly gathered at the wetland for intertribal meetings and ceremonies. The site has outstanding natural values and supports disjunct rare plant species, many old-growth River Red Gum (*Eucalyptus camaldulensis*) trees, a high diversity of bat species and one of the most diverse and intact bird communities in the inner city.

Bolin is one of only several billabongs remaining from at least 50 that were formerly scattered along the Chandler Basin, a floodplain basin of the lower Yarra River formed by an ancient lake system. In the early days of European settlement wetlands were seen by many as unclean and disease ridden areas, and most of the billabongs were filled in to utilise the ground for agriculture, roads and sports fields. Groundwater was drained to make way for agriculture and several of the billabongs were used as tip sites and filled with garbage.

Of the several remaining billabongs, Bolin is the only wetland whose bathymetry and vegetation has not been significantly modified, although the hydrological processes that determine its wetting and drying cycles have been greatly altered. The Yarra River was originally a perched stream that flowed through a complex of swamps and billabongs which would fill regularly when the Yarra spilled its banks (Beardsell, unpublished information). However by the late twentieth century the base level of the Yarra River had dropped severely due to groundwater drainage and river regulation, and the wetland now floods irregularly.

Under 'natural' conditions Bolin would receive regular overbank flows from the Yarra, resulting in near annual inundation and permanent open water existing in all but extended drought periods. Under current conditions a severe reduction in the higher flow events has increased the likelihood of the billabong drying out and remaining dry over long periods, thus favoring terrestrial species, particularly weeds, over native aquatic and semi-aquatic plant species.

By the late twentieth century Bolin had been greatly impacted by agricultural practices and weed invasion. Cattle were present in the wetland until recently, pugging the banks and grazing sensitive aquatic herbfields. Weeds had invaded much of the site, and Wandering Tradescantia (*Tradescantia fluminensis*) and Blackberry (*Rubus fruticosus*) blanketed large areas. This highly modified habitat was now unsuitable for many ground foraging birds and restricted recruitment of native plant species. The surrounding floodplain had been mostly cleared and developed, although Bolin still retained a relatively intact canopy and shrub layer.

Early management and research

In the 1990's, Parks Victoria began a program of restoration that continues to this day. First the Blackberry and Wandering Tradescantia thickets were removed with herbicide, as the extent of these weeds was too great to tackle by hand. Areas that were previously cleared were planted with a range of trees and shrubs, which increased the extent and quality of habitat.

During this time research projects were undertaken to document the billabong's botanical composition and investigate its current hydrological regime. It was found that Bolin supported an assemblage of rare plant species, many that are of disjunct occurrence and more common in northern Victoria, including Matted Water Starwort (*Callitriche sonderi*), Matted Starwort (*Stellaria caespitosa*) and Short-fruit Nardoo (*Marsilea hirsuta*). Hydrological studies concluded the billabong was flooding far less than historically, and an appropriate flooding regime was recommended.

Another study that involved analysis of a core sample taken from the Billabong (Paul *et. al*. 2002) found that sedimentation rates had increased up to 30 times since European settlement. This is probably due mostly to river regulation, as the Yarra now spills its banks into Bolin only during big flash-flood events, which bring large volumes of silt and turbid water.

*Wandering Tradescantia (*Tradescantia fluminensis*) flower (left) and smothering vegetation (right).*
Photos: © RCH Shepherd (www.weedinfo.com.au), APII, ANBG.

Intensive restoration

In 2004 an intensive program of vegetation management was begun by Parks Victoria ranger Cam Beardsell. The program, begun shortly after the Yarra flooded into Bolin in December 2004 and in February 2005, included hand weeding of exotic grasses and herbs in the northern bay of the billabong, which supported the highest density of rare native flora. Although removal of Wandering Tradescantia and Blackberry had many positive effects, they were replaced by an equally threatening assemblage of exotic herbs and grasses which began to proliferate in the post-flood conditions. Many days were spent hand-weeding with several volunteers, until the northern bay was almost completely weed free.

During these works additional rare flora species were discovered, many of which are absent or known only from very few other occurrences in the Melbourne region, and demonstrate biogeographic affinities with the Murray River floodplain. Seed collected from several of the most localised species was grown by the Friends of Yarra Parklands nursery and used to enrich the current populations at Bolin.

Drying

At the time of writing in 2010, the billabong is completely dry. Dense thickets of River Red Gum are establishing in its floor in areas normally occupied by aquatic herbfields, while all of the most significant plant species have temporarily died off in the northern bay. After so many years of drought and river regulation, the river hasn't flooded for five years with no promise it will occur anytime soon. Localised plant extinctions may eventually occur and the regenerating River Red Gums may establish permanently, drying the soil further and altering light conditions.

Hydrological restoration

In the midst of these dire conditions, Parks Victoria and Manningham Council are currently working on an exciting stormwater harvesting project to restore the natural hydrological regime to the billabong. The current plan is to initially pump water into it from the river, using screens to prevent colonisation by European Carp which severely impact aquatic vegetation. Once the billabong is full, the water level will be maintained by allowing entry of treated water from stormwater wetlands to be constructed nearby. The stormwater will be regulated so that the natural regime of flooding and drying can be maintained thus delivering significant biodiversity enhancements to the billabong.

Conclusion

The processes that have eliminated and degraded billabongs of the Chandler Basin operate across floodplains throughout Victoria and Australia. The management works at Bolin Bolin Billabong span at least 20 years and act as a model for restoration of billabongs elsewhere. The works that continue to progress have secured this wetland as one of the greatest jewels of the Yarra River.

Acknowledgements

The authors gratefully acknowledge Cam Beardsell for providing ecological and historical information and Deborah Bogenhuber for providing valuable comments on the draft article. We thank all others who have played a part in the restoration of Bolin Bolin Billabong, particularly Damien Cook and Glen Jameson.

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Floristic values and hydrological threats to freshwater claypans in Drummond Nature Reserve, Western Australia

Wendy Chow, Ryan Vogwill and Matt Forbes

West Australian Department of Environment and Conservation, Perth. Email: Wendy.Chow@dec.wa.gov.au

Introduction

Drummond Nature Reserve, located 100 km north-east of Perth, is 439 ha in area. Prior to 1993, when the reserve was gazetted, it was freehold land used for stock grazing (Keighery *et al*. 2002). The majority of the land surrounding the reserve has been cleared, although some fringing areas have been re-vegetated.

The reserve has a vascular plant flora of at least 439 taxa (Keighery *et al*. 2002). This includes seven plants on the state's list of poorly known taxa and two that are declared rare (threatened) flora under the *Wildlife Conservation Act 1950* (WA) (Keighery *et al*. 2002).

Also located within the reserve are two freshwater claypans, described as 'claypans with mid dense shrublands of *Melaleuca lateritia* over herbs' (Keighery *et al*. 2002), some of the last of their type to remain in their natural state. The significance of these claypans was highlighted through surveys across the South West Botanical Province (Gibson *et al.* 2005). Land clearing has altered the area's hydrology and may threaten these claypans. As a consequence of their rarity and threats, the claypans have been proposed as a threatened ecological community. The West Australian Department of Environment and Conservation is undertaking hydrological and floristic investigations of them to better assess threats and indicate required management actions.

The shrub layer of Melaleuca lateritia *in the north-east claypan. Photo: Wendy Chow.*

Geology and hydrology

The reserve occurs high in the landscape between the Solomon and Mt Anvil sub-catchments of the Avon River. It consists of a series of lateritic ridges, underlain by highly weathered, Archaean bedrock (Commander *et al*. 2001) that outcrops in numerous areas. The reserve is bordered to the west by a topographic high and its central area is characterised by a gently undulating laterite plateau.

The south-west claypan is immediately adjacent to the southern and western boundaries of the reserve. The north-east claypan lies within the reserve's interior, with flow boundaries to the north and west. Surface water flows from the west into the south-west claypan and the north-west corner of the reserve. The central lateritic plateau acts as a topographic (bedrock) high between the north-west and south-west areas, probably separating the area's groundwater and surface water systems. Kaolinite and illite dominate the claypan sediments, with minor sands and lateritic gravels. The two claypans are dry in summer but have up to 50 cm of surface water during the winter months.

Biota

The claypans of the reserve are described as predominantly deeper basin claypans characterised by aquatic (*Hydrocotyle lemnoides*) and amphibious (e.g. *Glossostigma diandrum, Villarsia capitata* and *Eleocharis keigheryi*) flora taxa, with the shrub layer of *Melaleuca lateritia*. They also contain a number of the state's uncommon taxa including *Hydrocotyle lemnoides* and *Schoenus natans* (Keighery *et al*. 2002).

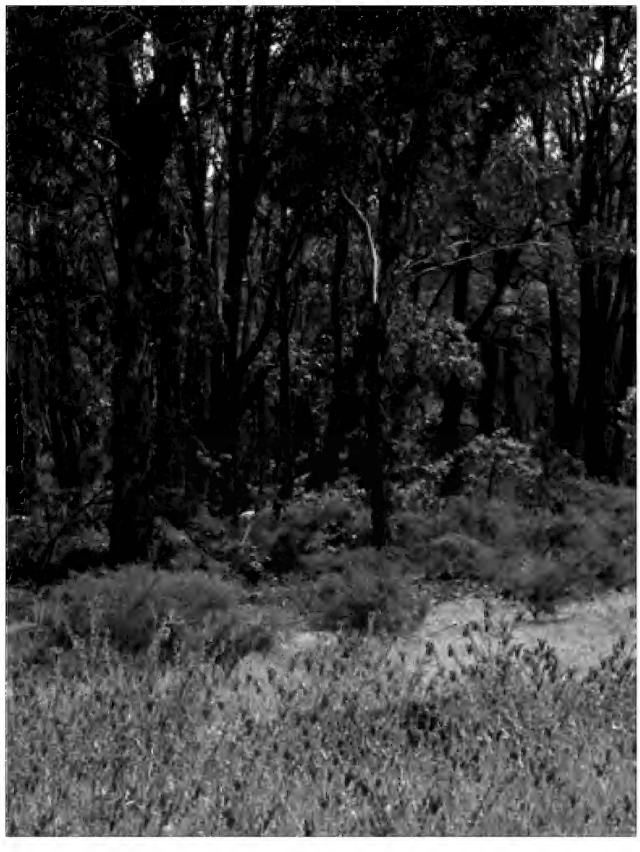
Hydrology and threats to biota

Investigations of topography, hydrology and hydrogeology indicate that the reserve can be delineated into three distinctive hydrological sub-regions: the north-west, east and south-west. The north-east and south-west claypans are situated in the east and south-west sub-regions respectively. It is likely that the north-west section is hydrologically separated from the remainder by impervious geological bodies. As a result, shallow and saline groundwaters that are impacting the Wandoo (*Eucalyptus wandoo*) woodlands in the north-west are unlikely to affect the rest of the reserve.

There is currently no hydrological connection between the claypans and groundwater in the south-west portion of the reserve. However, more investigations and ongoing monitoring are required. Existing evidence suggests that during heavy rainfall events unnaturally large volumes of surface water flow into the reserve at the south-west corner. This threatens the south-west claypan through the introduction of weeds and nutrients, and altered water regimes. The increased surface water inflow could also increase groundwater recharge and result in groundwater discharge into the south-west claypan.

Between 2007 and 2009 evidence of excessive levels of total nitrogen were identified within the surface and sub-surface waters of the south-west claypan. High nitrate levels were also identified in groundwater along the reserve's western boundary. Recent concentrations are greater than values observed during macroinvertebrate surveys in 2004, suggesting that nutrient influxes into the reserve and south-west claypan are increasing.

In contrast to the south-west claypan, the north-east claypan catchment is almost entirely contained within the reserve. The claypan itself is about 400 m from any cleared land and is bounded to the north and west by impermeable material. As a result, it is unlikely to be affected by surface water flows from agricultural land, or the high groundwater levels in the north-west of the reserve. Weeds present in this claypan probably originate from animal activity and grazing impacts.



*Invasion by the weed Paterson's Curse (*Echium plantagineum*) in the foreground along the south-western corner of the reserve may threaten the south-west claypan. Photo: Matt Forbes.*

Gaining floristic data

One of the main challenges faced in the collection of claypan floristic information is the intensive survey effort required. In seasonal clay-based wetlands the taxa germinate and flower at different times. Some flower during periods of inundation and others flower when the claypans are dry. To gain a representative species list there is a need for the claypans to be sampled multiple times to ensure that all the annual and ephemeral taxa are recorded. This is also the case for ongoing survey work intended to help establish linkages between floristic and hydrological changes in the reserve.

Future work

The original hypothesis for the altered hydrology of the reserve was that observed impacts were all groundwater driven and the major threat was waterlogging and salinisation. Increased recharge in the catchment was hypothesised to be creating a rising saline water table. While this is typical of a valley floor scenario, the reserve occurs much higher in the landscape. This confirms the need to ensure that local hydrology is assessed and assumptions are not made based on typical drivers of degradation.

More detailed investigations have identified that rising saline groundwater is causing the impacts in the north-west corner of the reserve but not within the vicinity of the two claypans, but this needs to be further monitored and assessed. However, the south-west claypan is exposed to agricultural runoff, which contains high levels of nutrients and weed seeds; this appears at present to be the greatest threat to the high floristic values of the reserve. The north-east claypan is isolated from agricultural runoff and rising groundwater. Further geochemical investigation of ground and surface waters is required to confirm this, and ongoing monitoring is essential to protect the reserve's high biodiversity values.

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Rehabilitating a dry wetland on the southern tablelands of New South Wales

Michael Pattison

WetlandCare Australia, Ballina, NSW. Email: michaelpattison@wetlandcare.com.au

Introduction

WetlandCare Australia has partnered with the Hawkesbury-Nepean Catchment Management Authority to enhance the condition of wetlands in the southern region of the catchment. The Lake Bathurst system, south of Goulburn, is an ephemeral, upland lagoon system comprising two small freshwater lagoons (The Morass) that flow into a terminal saline lake (Lake Bathurst). The system lies in a 1350 ha basin with internal drainage and a unique geology.

Lake Bathurst and The Morass are listed in the Directory of Important Wetlands in Australia (Environment Australia 2001) and are also listed by Birds Australia as an 'Important Bird Area'. The ongoing drought conditions have seen Lake Bathurst dry for nearly 10 years which has caused dramatic changes in the vegetation composition and a significant decrease in bird populations.

Lake Bathurst and The Morass project

The project began in 2007 with the preparation of a management plan for the wetland to identify the threats to, and values of, the site and provide a framework for ongoing rehabilitation. Individual property plans were then undertaken with interested landholders and stakeholders to improve the condition of wetland areas on private property. This led to a series of on-ground works programs that have focussed on improving natural regeneration of the lake margin vegetation, and weed and feral animal control.

The European Rabbit (*Oryctolagus cuniculis*) was recognised as a major impediment to successful wetland regeneration. The Livestock Health and Pest Authority was therefore contracted to undertake aerial mapping of rabbit harbour (burrows, blackberry thickets and other refuge) and subsequent control programs. This involved ripping burrows, poisoning and the use of explosives. The project had a 95 per cent success rate in eradicating the rabbit population and harbour across Lake Bathurst. Landholders have taken on the responsibility of ongoing control.

Remnant fencing and revegetation works have also been carried out on a number of properties equating to:

- 10 ha of wetland native vegetation protected by fencing;
- 5 ha planted to native wetland species;
- 7 ha of wetland connectivity reinstated; and
- over 5000 ha of pest animal control.

The greatest threat to biodiversity

One of the main issues for landholders and top priority for management at Lake Bathurst and The Morass is the control of the invasive grass, Serrated Tussock (*Nasella trichotoma*), and its associated impacts on threatened species, native flora and fauna. This is recognised by landholders and stakeholders alike. The weed is listed as a Class 4 noxious weed in the Goulburn-Mulwaree area.

The main control method currently used by landholders is herbicide application (mainly *flupropanate*) via boom and spot spraying. This method has some positive (although short-term) effect, but because many native grasses are susceptible to flupropanate, the total vegetative groundcover is substantially reduced by its application.

A consequence of the non-selective impact of this herbicide is that no competitive native species are retained to prevent the re-establishment of Serrated Tussock seedlings. A less stable mixture of broadleaf weeds and annual grasses invade while the chemical is still active. Once the chemical has degraded or leached out of the root zone, Serrated Tussock seedlings rapidly re-colonise into the large areas of disturbed, bare ground. As a result, repeat herbicide applications are likely to favour Serrated Tussock. Over time the Serrated Tussock seedbank increases relative to the native species seedbank, leading to weed re-establishment at even higher densities, eventually resulting in a Serrated Tussock monoculture (see Figure 1).

*Figure 1. Serrated Tussock (*Nasella trichotoma*) at Lake Bathurst. Photo: Michael Pattison.*

In 2010 the project partners will work with landholders and stakeholders to coordinate an integrated Serrated Tussock control program aiming to reduce the spread of the weed and increase biodiversity. The focus will be on containing Serrated Tussock within the lake boundary and concentrated control efforts on adjacent properties. Under the current low fertility conditions at the lake, it is likely that some native grasses, in particular summer growing perennial grasses, will be able to grow more vigorously than Serrated Tussock. Greater emphasis will therefore be placed on pasture management to maintain ground cover at a level sufficient to prevent the weed from invading.

Should Lake Bathurst return to full water capacity, the weed would be isolated to higher ground and manageable with the current level of management input by surrounding landholders. Unfortunately, the dry lake bed provides an immense, continual source of seed which can be carried by wind for up to 20 km (Osmond *et al.* 2008), leaving landholders with a seemingly endless battle.

Figure 2. Pelargonium *sp. (G.W. Carr 10345). Photo: Michael Pattison.*

Threatened species

A number of threatened species have been recorded at Lake Bathurst and The Morass. They include:

- Green and Golden Bell Frog (*Litoria aurea*);
- Blue-billed Duck (*Oxyura australis*);
- Freckled Duck (*Stictonetta naevosa*);
- Magpie Goose (*Anseranas semipalmata*);
- Spotted-tailed Quoll (*Dasyurus maculates*);
- Koala (*Phascolarctos cinereus*);
- Creeping Hop-bush (*Dodonaea procumbens*); and
- the recently nominated Native Geranium (*Pelargonium* sp. (G.W. Carr 10345)) which is known to exist at only four sites in New South Wales (DECCW 2009).

Staff members from the project partners, the Royal Botanic Gardens, the Department of Environment, Climate Change and Water and the Land and Property Management Authority visited Lake Bathurst with the hope of finding the elusive *Pelargonium* sp. in a sea of Serrated Tussock. Armed with cameras, maps, a GPS and some historical co-ordinates from a previous sighting, we headed out across the dry lake bed to one of the 'islands'. After a considerable search a few small patches of the plant were found surviving under weed encroachment and grazing (see Figure 2). A project is now being developed to fence these patches to protect them from grazing. Advice will be sought on the best way to manage the threats posed by Serrated Tussock as spraying to control the weed is also considered a threat.

Management difficulties

We have found the landholders and other stakeholders to be very supportive of the project. The key to continued success and weed management remains with on-going landholder networking and project development, which includes continual funding. The noxious weed infestation and encroachment continues to be the most pressing management problem. Trials continue to identify appropriate management techniques for a dry wetland bed (while praying for rain).

Overgrazing has contributed significantly to the spread of Serrated Tussock as it germinates rapidly on bare or disturbed ground. Improved grazing management techniques are an essential component of long-term weed control. This has been a difficult message to impress upon landholders under the dry conditions.

Into the future

The project has achieved significant success so far with habitat connectivity being re-established from north to south of the lake through revegetation works. Areas of remnant snowgums (*Eucalyptus pauciflora*) have been fenced to restrict grazing and improve natural regeneration of the lake margins, which has been aided by the rabbit control program. We aim to continue developing projects with landholders in the areas of fencing and revegetation whilst implementing the long-term weed control program.

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The invasion of common reed (*Phragmites australis*) in Chesapeake Bay, USA

Dennis F. Whigham[1], Karin M. Kettenring[2], Melissa K. McCormick[1] and Heather Baron[3]

[1]Smithsonian Environmental Research Center, Edgewater, Maryland, USA. Email:whighamd@si.edu

[2]Utah State University, Logan, USA.

[3]Oregon State University, Corvallis, USA.

Introduction

Species in the reed genus *Phragmites* (Poaceae) occur on all continents. The various species are highly valued by some cultures, such as the marsh Arabs in Iraq whose culture developed in and is interwoven with *Phragmites*-dominated wetlands. *Phragmites* is used in many countries for a variety of purposes including thatching for roofs, and making mats, baskets and paper.

There is a native subspecies of *Phragmites australis* in North America (Saltonstall *et al*. 2004) but European haplotypes have also become established there and are spreading. The non-native haplotype is recognized as an invasive species that has significant detrimental effects on native plants and animals. Much of the recent spread of the non-native genotype has occurred in freshwater wetlands but it has also been spreading rapidly in brackish wetlands along the Atlantic Coast of North America (Meyerson *et al*. 2000).

Working in the Chesapeake Bay on the mid-Atlantic coast of the US (Figure 1), our research group found that non-native *P. australis* was most abundant in wetlands surrounded by upland habitats with human activities such as suburban and industrial development (King *et al*. 2007). A similar pattern has been documented in the Rhode Island brackish wetlands further north in New England by scientists at Brown University (e.g. Silliman and Bertness 2004). The potential threat associated with the continued rapid expansion of the non-native haplotype of *P. australis* in brackish wetlands in the Chesapeake Bay is enormous, as eventually it could result in the displacement of almost all native wetland species, including the native subspecies that sometimes co-occurs with the non-native haplotype.

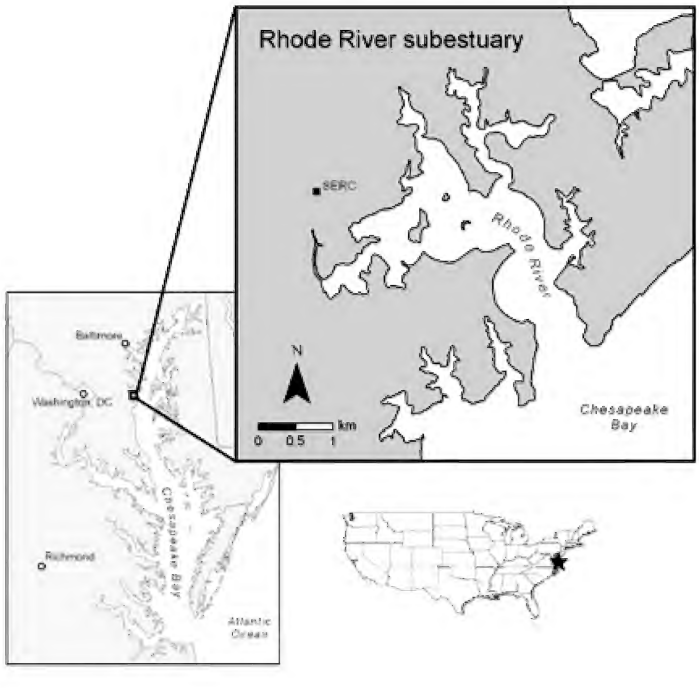

Figure 1. Map showing the location of the Rhode River sub-estuary of Chesapeake Bay. The Smithsonian Environmental Research Center is located on the Rhode River watershed.

Understanding how it spreads

Our research group has been conducting a series of studies designed to understand the underlying ecological reasons for the rapid spread of non-native *P. australis*. Historically, this has been attributed to physical disturbance followed by the establishment of plants from fragments of rhizomes (Figure 2a). The rapid spread of *P. australis* in wetlands at our primary research site in the Rhode River sub-estuary (Figure 1) suggested that spread was associated more with establishment from seeds (Figure 2b) than from rhizomes (McCormick *et al*. 2010). In the Rhode River, the number of patches of the plant increased from 5 in 1971-1972 to more than 200 by 2007, most of the expansion occurring since the 1980s.

Using molecular tools, we found that almost all the patches of *P. australis* in the Rhode River and nine other sub-estuaries throughout Chesapeake Bay were composed of multiple genotypes and that viable seeds were being produced predominantly in multiple-genotype patches (Kettenring *et al*. 2010). Multiple-genotype patches can improve the likelihood of cross-pollination and thus viable seed production in *P. australis*.

Our findings have led to a better understanding of the reasons for the rapid spread of the non-native *P. australis* haplotype in both disturbed and undisturbed wetlands. The non-native haplotype grows faster and produces more seeds when different haplotypes exchange pollen. Developing seedlings establish particularly well in nutrient rich environments—the current condition in the Chesapeake Bay, which is suffering in numerous ways from eutrophication and other anthropogenic activities. The increasing

Figure 2. (a) A section of Phragmites australis *rhizome which became separated following shoreline erosion at Parkers Creek, Chesapeake Bay. Most of the roots and rhizomes have died, but a few parts of the rhizome that potentially can produce new shoots are still alive and green. (b)* Phragmites australis *inflorescences, Rhode River sub-estuary.*
Photos: (a) Dennis Whigham and (b) Karin Kettenring.

production of viable seeds in more and more patches that contain multiple genotypes leads to an ever increasing probability that new patches will become established as more viable seeds are dispersed over a wider area. Eventually the establishment of new patches from seeds becomes a self-perpetuating process and disturbance, which was necessary for the initial establishment, is no longer required.

A new management model

Our research leads to a new paradigm for managing non-native *P. australis*. Typically herbicide is used to remove individual patches. Our research suggests that the removal of one or a few patches will have little long-term effect because patches will quickly re-establish from seeds that are being produced in extant patches or persisting in the seed bank. Consequently, effective management can occur only when all patches within a sub-estuary are eliminated. Eliminating the sources of seeds is essential because almost all patches contain multiple genotypes and will continue to produce seeds that potentially will initiate new colonization.

Once all patches have been eliminated within a sub-estuary, diligent long-term management will be effective through periodic monitoring and removal of individuals that become established in the future. This approach will eventually be more cost effective and can be accomplished by local citizen volunteers or organizations such as the Riverkeeper groups that are common in many Chesapeake Bay sub-estuaries (e.g. www.westrhoderiverkeeper.org/).

The result of not applying a sub-estuary level approach to management of *P. australis* could eventually be the complete dominance of the non-native genotype in brackish tidal wetlands in Chesapeake Bay. While the cost of removing the plant at the sub-estuary scale may initially be high, now is the time to evaluate this approach to its management because delay will result in the continued march of the non-native haplotype into brackish tidal wetlands of Chesapeake Bay. It is still early enough in the invasion process that management, restoration, and conservation of wetlands dominated by native species may be possible.

A lesson for elsewhere?

Our research has potential implications for other parts of the world where *Phragmites australis* occurs. In areas where the native genotypes may be declining, the importance of seed production should be explored. In wetlands where *Phragmites* suddenly begins to spread, the genetic characteristics of the new patches need to be investigated to determine if it is a native or non-native haplotype. If it is non-native, early detection and management need to be employed.

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Removing the Devils Claw from Gregory National Park, Northern Territory

Karlie Goetze and Derek Sandow

Department of Natural Resources, Environment, The Arts and Sport, NT. Email: derek.sandow@nt.gov.au

Introduction

Volunteers who love nature and are keen to spend a week in one of the Northern Territory's largest and most picturesque national parks were being called on to participate in the 2010 Devils Claw Festival being held on 12-16 April. The Festival is a volunteer environmental project run biannually by the Northern Territory Parks and Wildlife Service in Gregory National Park, located in the remote north-west region of the Territory near the Western Australia border.

Gregory National Park features rugged and spectacular landscapes of limestone ranges and gorges, magnificent river and tributary systems, and significant traces of Aboriginal culture, European exploration and pastoral history all within its 13 000 km^2 area. The riparian habitats along the river systems are home to many threatened native species including the Purple-crowned Fairy Wren (*Malurus coronatus*) and the Gouldian Finch (*Erythrura gouldiae*) but these habitats are under threat by Devils Claw (*Martynia annua*).

Devils Claw: a nasty weed

Devils Claw is a fast growing annual plant native to Central and South America that was introduced to Australia as an ornamental plant in the late 1860s and established in the Northern Territory after World War II. It is a large bushy herb that can grow to about 2 m high, and has large kidney shaped, hairy leaves that are unpalatable to livestock. Its bell-shaped flowers are about 5 cm long and range from white to pink in colour. The spiny seed capsules can injure livestock and native animals.

While most Devils Claw seeds germinate within the first two years after forming, many can remain viable for up to 10 years, which is why control programs need to be lengthy to ensure all possible infestations are removed.

The Northern Territory has declared Devils Claw a Class A weed (to be eradicated) and a Class C weed (not to be introduced into the Northern Territory). The main methods of controlling it are spraying with herbicide, slashing and grubbing or hand pulling.

Tackling the weed in Gregory National Park

Of the four river systems within Gregory National Park (the East Baines, West Baines, Humbert and Wickham rivers), Devils Claw has infested the East Baines River, the Humbert River and a tributary of the Wickham River called Gibbie Creek.

A Devils Claw eradication program was commenced in the park in 1992. Although all control methods have been used, it's been found that hand pulling is the most efficient, thorough and environmentally sound method. The control operation involves two teams, one on either side of the waterway, walking along searching, hand pulling, recording and mapping all Devils Claw plants encountered.

Devils Claw foliage and flowers (left) and seed pods (right). Photos: NT Parks and Wildlife.

Devils Claw Festival

The first Festival held in May 2009 was extremely successful, with 12 volunteers and eight park rangers involved. For the first time since the eradication program commenced no Devils Claw was found in the East Baines area, which had an infestation of over 17 000 plants when it was discovered 18 years ago. On that same field trip 460 plants were removed from the Gibbie Creek section and 420 plants from the Humbert River section. Further work on the Gibbie Creek section was carried out by park rangers and Traditional Owners in September reducing the plant numbers by a further 389.

During the second Devils Claw Festival held in December 2009 a team of 12 volunteers, Traditional Owners and park rangers did not discover any new seedlings for the first time ever. Devils claw is spread predominately by floodwater but can also be spread by feral animals. As most of the plants higher in the catchments had been removed, this reduced the seed bank and may have been why no new plants were discovered during the festival. There was only scattered rainfall in October and November 2009 which could also have contributed to the seeds being unable to germinate.

We're not sure what to expect during the Devils Claw Festival at the end of the wet season in April 2010, as the rainfall was still below average at the time of writing.

Making a difference

Volunteers who participate in the Devils Claw Festival arrange their own transport to the ranger station in Timber Creek, which is located on the Victoria Highway about halfway between Katherine in the Northern Territory and Kununurra in Western Australia. Upon arrival all the food, accommodation and transport within the Park is provided by the Parks and Wildlife Service.

Volunteers helping to eradicate Devils Claw from riparian habitats within Gregory National Park, Devils Claw Festival 2009. Photo: NT Parks and Wildlife.

The Festival is held along some remote stretches of river in spectacular surrounds that are rarely visited. The country is rugged, the weather hot and humid and the work physically demanding, but it is a week volunteers never forget. It is the friendship, character and spirit of the volunteers that make the Devils Claw Festival; the people who give up their time to make an important environmental contribution are great company to keep.

The work of volunteers and local Indigenous groups over 18 years has been crucial in reducing the impact of this invasive weed. Volunteers can get a real sense of pride and achievement in helping to preserve the pristine environment within Gregory National Park, and the Devils Claw Festival is great fun.

For further information or to register your interest contact Derek Sandow on 08 8975 0833 or email derek.sandow@nt.gov.au.

Tackling wetland weeds: reducing impacts and restoring native vegetation on the Far North Coast of New South Wales

Laura White and Garry Owers

WetlandCare Australia, Ballina, NSW. Email: laurawhite@wetlandcare.com.au

Introduction

The Bungawalbin, located south of the town of Coraki on the Far North Coast of New South Wales (NSW), is a 1770 km^2 sub-catchment of the Richmond Catchment. WetlandCare Australia is managing a wetland restoration project in the Bungawalbin funded by the Northern Rivers Catchment Management Authority. The project will involve fencing off wetlands and controlling weeds in partnership with landowners. Two of the worst weeds identified at the location are Cat's Claw Creeper (*Macfadyena unguis-cati)* and the aquatic weed Salvinia (*Salvinia molesta*).

Cat's Claw Creeper

Cat's Claw Creeper, a native of South America, was introduced to Australia as an ornamental and screening plant. This vigorous, perennial climber has become an aggressive riparian weed in eastern Australia. The vine develops woody stems which can grow over 20 m long and 15 cm thick. Leaves are positioned in opposite pairs along the stem, with each leaf comprising two pointed leaflets and a sharp three-pronged tendril (like a cat's claw), which allows the weed to climb vertically up tree trunks. Aerial roots that attach to the trunk of host trees assist in climbing. Each plant also produces numerous, persistent, underground tubers from which it can regenerate readily.

This vine has become a severe environmental weed, devastating native riparian vegetation. It outcompetes understorey plants by forming a dense mat over the ground, and its woody stems grow prolifically into the canopy, smothering and eventually killing large trees. Cat's Claw Creeper is already well established in south-eastern Queensland and north-eastern NSW, where it is having significant impact and threatening endangered ecological communities, including littoral rainforest and eucalypt floodplain forest (CRC Weed Management 2008). If not kept in check, Cat's Claw Creeper will become more abundant within its current range and expand along the east coast.

Salvinia

Salvinia is a free-floating aquatic fern, native to Brazil, which was originally introduced as a pond or aquarium plant, and has now become a severe aquatic weed in Australia. Its branching stems float on the water surface producing pairs of oval shaped leaves with looped hairs. Brown root-like structures extend from the stems down into the water. In young plants the leaves lie flat, and separate on the water's surface, but as plants mature and the infestation becomes dense, leaves become crowded and tightly packed like a concertina. If left untreated, the plants clump together forming dense mats on the surface of still, and slow moving water and surrounding wet mud. Salvinia does not produce seeds or spores in Australia but spreads readily from tiny plant fragments, which can be introduced to new waterways through boats, flooding and aquatic birds.

Salvinia is regarded as one of Australia's worst weeds for its invasiveness and environmental impacts (CRC Weed Management 2003). It can grow very rapidly from a single small frond to a dense mat covering the entire water surface. These mats reduce light penetration and impede oxygen exchange making the water unsuitable for aquatic flora. This aggressive weed is widespread along the east coast of Queensland and NSW, with smaller pockets elsewhere in Australia. It has the potential to become widespread within every state of Australia.

An integrated solution

WetlandCare Australia is working with landholders at Bungawalbin to combat the devastating impacts of these weeds. A combination of manual removal and biological control is being employed to assist native wetland vegetation to regain a foothold.

Cat's Claw Creeper

In established infestations, eradication of Cat's Claw Creeper is almost impossible and a key management goal is the reduction of impacts (CRC Weed Management 2008). Chemical control can be effective, however there is the risk of damage to native vegetation, enabling the target weed to regrow readily. Considering this, the current approach being employed involves cutting all the climbing weed stems and then manually removing them from tree trunks within the infestation. This leaves the tops of the weed to die *in situ*, while causing minimal disturbance to native species.

Additionally, a leaf-sucking tingid bug (*Carvalhotingis visenda*) is being deployed as a biological control agent. These insects are natural predators of the plant and can cause significant damage when introduced to well-established infestations, reducing the rate of spread and vigor and giving native plants a chance to re-establish. Industry and Investment (formerly The Department of Primary Industries) currently rears and supplies this agent for release. Abundant and intact native vegetation is often the best defense against riparian weed invasion, and it is hoped that with the intervention of integrated control measures the resilience of the affected riparian vegetation can be restored.

Salvinia

A combination of manual and biological control techniques is also being used to target Salvinia infestations in the area. Like Cat's Claw Creeper, Salvinia is very hard to eradicate, although various control methods can reduce its impacts (CRC Weed Management 2003). Chemical control of Salvinia can be effective, however the dead material sinks, further clogging the system and releasing nutrients, which degrade water quality and encourage regrowth. Additionally the chemicals themselves may harm wetland flora. Instead, a technique is being trialed that involves the manual removal of the bulk of the plant material from small wetlands using a 23 mm mesh nylon trawler net, attached to a 4WD vehicle. The net measures 1 m deep and 5 m long, with floats connected to the top, and weights connected to the bottom to drag live Salvinia from the water surface as well as the old dead material below (Figure 1). This will ensure the removal of the living weed, as well as its clogging, nutrient releasing, dead biomass.

Biological control with the Salvinia Weevil (*Cyrtobagous salviniae)* is also being implemented to prevent regrowth of remaining plant fragments. The combined attack of weevil larvae feeding on stems and adults feeding on buds

Figure 1. Dragging Salvinia mat from a Bungawalbin wetland using a trawler net towed by a 4WD, 2009. Photo: John Blatch

can cause plant death, eventually sinking the dense mats (van Oosterhout 2006). Over a period of months or years Salvinia Weevil can reduce a large infestation significantly and prevent it from regrowing as the plant and Weevil keep each other in balance. Although well-established in many areas throughout Australia, the weevil cannot disperse large distances on its own and often needs to be introduced into an infestation. Industry and Investment breeds and supplies the weevil for introduction. On-site weevil rearing by landholders is also being trialed to maximise the dispersal and impacts of this agent.

It is envisaged that manual removal of the Salvinia biomass will reinstate light penetration and water health, allowing native aquatic plants to re-emerge while weevils control Salvinia regrowth. Salvinia thrives on excess nutrients so strategic land management to keep wetlands healthy will also benefit in controlling this invasive weed.

Conclusion

Successful management of wetland weeds often involves a focus on reducing their immediate impacts and spread, as eradication may often be unachievable in well-established infestations. A combination of strategic manual removal and biological control techniques can be used to reduce the biomass and vigor of the weeds with minimal damage to native species. This approach can allow native vegetation to re-establish, improving resilience to re-infestation.

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Adelaide Botanic Gardens First Creek Wetland Aquifer Storage and Recovery Project

Phil Ainsley and Andrew Pill

Botanic Gardens of Adelaide. Email: phillip.ainsley@sa.gov.au

Introduction

The Botanic Gardens of Adelaide and Department for Environment and Heritage (South Australia) are soon to commence the establishment of a storm water aquifer storage and recovery project, known as the Adelaide Botanic Gardens First Creek Wetland Aquifer Storage and Recovery Project. The scheme will allow stormwater to be diverted from First Creek, treated through a wetland before being stored in, and subsequently recovered from, an underlying aquifer. The project will ensure that the Adelaide Botanic Gardens has access to a secure water supply for irrigation purposes and will significantly reduce the Garden's demand for potable water from the River Murray.

It is anticipated that the system will completely replace the use of potable water over a five year period, with an anticipated usable capacity of 130-135 megalitres (ML) per annum.

Background

The Adelaide Botanic Gardens uses about 120 ML of water annually. Although it has a permit to use mains water in times of prolonged drought and severely restricted water availability, the Garden would much prefer not to rely on a mains water supply. The project will provide an alternative and slightly larger water source, with a usable capacity up to 135 ML per annum. The system will also provide

surplus water to the nearby Botanic Park, which currently uses 40 ML of water that is primarily sourced from the River Torrens.

Project aims

The primary aims of the project are:

- significantly reduce the Garden's reliance on potable water for irrigation
- promote sustainable use of alternative water supplies in an urban environment
- reduce the detrimental impact of storm water pollutants in the First Creek catchment area on the downstream Torrens Lake.

Scope of works

To be able to complete the project the following works will be undertaken:

- construction of a gross pollutant trap, sedimentation basin, macrophyte zone and storage basin
- re-alignment and landscaping of the First Creek watercourse
- construction of pump rooms containing plant and equipment required for injecting treated water into the aquifer and recovering stored water for irrigation purposes
- construction of low level retaining walls, paths and visitor amenities, including a boardwalk through the macrophyte wetland zone.

Water storage, recovery and a wetland

An Aquifer Storage and Recovery (ASR) system refers to the process of storing water in an aquifer during periods of water availability, and recovering the water when required in drier seasons. Prior to injection into the aquifer the water passes through a sedimentation basin and into a wetland which slows the water, allowing natural processes (including nutrient and bacteria removal and sedimentation) to occur which improve water quality.

The project will see the development of an off-line wetland system where stormwater will be diverted from its normal flow down First Creek and be allowed to flow under gravity through the wetland. The system will receive stormwater flows via a control structure used to limit the maximum flow into the wetland. The control structure also incorporates a gross pollutant trap that treats all of the stormwater flow down First Creek.

The water flowing into the ASR will pass through a Continuous Deflective Separation System to capture gross pollutants and separate sediments from stormwater by centrifugal force. The gravity fed flow will then pass into a sedimentation basin (the wetland) with an average depth of one metre and an area of about 600 m^2, then cascade across a broad gravel weir into the macrophyte zone. This zone will contain areas of varying water depths and be planted with wetland plants. After flowing through the macrophyte zone the treated water will pass over a rapid sand filter and be directed into an injection bore into a fractured rock aquifer that is located at a depth of about 115 metres under the Gardens. Water will be treated and recharged into the aquifer over the winter months, and recovered over the drier summer period.

The other significant part of the proposed works is the landscaping and visitor amenity features, including a boardwalk over the wetlands and paths through and around the storage ponds. Project provision has been made for a series of education nodes along a wetland trail. Themes and stories for the interpretive aspect of the project will include:

- comparative experience, to contrast the sensory feel of the different areas
- mapping of cross sections and zones, to more closely examine the wetland treatment sequence and consider changes in biology and ecology across the system
- water testing stations to show the difference in water quality between the First Creek input and the stored irrigation water
- inspection station for the gross pollutant trap, pump rooms, and water treatment plants.

As part of the landscaping, the alignment of First Creek will be altered to create a more natural water course, together with an extensive program of planting and landscaping the areas surrounding the water system.

Construction works are scheduled for completion by the end of the 2011, with commissioning planned for March 2012. It is intended that Adelaide Botanic Gardens water use will become completely self-reliant after five years of its operation by 2016.

First Creek as it looks today, Adelaide Botanic Gardens. The area in the background is where the wetland site will be constructed. Photo: Phil Ainsley.

Supporting the wetland community to protect and restore Australian wetlands

Kate Heyward

WetlandCare Australia, Ballina, NSW. Email: kateheyward@wetlandcare.com.au

WetlandCare Australia is a national not-for-profit, non-government science-based organisation, with a mission to support the community in the protection and repair of Australian wetlands. We do this through action-based partnerships with governments, landholders, natural resource managers, researchers and the community. Our focus is on on-ground community engagement in project delivery and the provision of technical expertise, education and local advice on best practice wetlands protection, biodiversity conservation, and management and rehabilitation. We are proud to have been protecting wetland biodiversity since 1991, especially in this, the International Year of Biodiversity.

WetlandCare Australia implements its mission by:

- supporting and using the latest science to develop and implement best practice wetland protection, conservation, restoration and management measures
- working in partnership with landholders, natural resource managers, community groups and governments to achieve local, regional and landscape scale change
- providing technical expertise and building community capacity to undertake on-ground action.

Conserving our living wetlands

As Australia's leading wetland conservation organisation, WetlandCare Australia is committed to improving the conservation, restoration and sustainable use of Australia's living wetland ecosystems. Our focus is on addressing national and international priorities in relation to wetlands for Australia and, more broadly, for our neighbours in New Zealand and the South West Pacific. WetlandCare Australia is working strategically and on-ground to:

- mitigate the impacts of climate change by improved management and protection of marine ecosystems and especially the vegetated coastal habitat, or Blue Carbon sinks
- improve the resilience of the Great Barrier Reef against climate change by improving biodiversity conservation, restoration and sustainable use of aquatic ecosystems in adjacent catchments
- improve the conservation, management, sustainable use and resilience of wetlands and rivers across eastern Australia
- protect and conserve Australia's unique wetland biodiversity including our iconic birds, fish and frogs
- improve the recognition and implementation of the Ramsar Convention for internationally significant wetlands across Australia and Oceania.

As part of our Ramsar Program to promote the wise use of all wetlands (through communications, education, participation and action) WetlandCare Australia provides a number of support tools, which are available to assist with information sharing, dissemination, networking and to improve awareness of what work is being conducted around Australia.

WetlandLink

WetlandLink is a free electronic newsletter which highlights current news from around Australia, and the world, each month. The newsletter currently has over 1200 subscribers. It provides the latest news and information on wetland rehabilitation and management case studies, wetlands under threat, research, education and resources along with any other wetland related news. To subscribe to WetlandLink go to WetlandCare Australia's website <www.wetlandcare.com.au>.

Wiki.WetlandLink

Wiki.WetlandLink is a national resource for wetland information. This is a new collaborative website where you can create, edit, exchange ideas and contribute to the latest wetland news and information (its like Wikipedia® for wetlands). Join the wetland wiki community by logging onto <www.wiki.wetlandlink.com.au>.

The Australian Wetland Alliance: NGO's working for wetlands

WetlandCare Australia is the current Secretariat for the Australian Wetland Alliance (AWA). The alliance is a growing association of non-government organisations (NGOs) which was formed at the Brisbane Conference of the Parties in 1996, to provide a network system and representation

for NGO's working in wetlands. AWA provides a communications tool for people working in NGOs via an email list for correspondence and through regular forums. It has over 70 members and is currently free for NGOs. For further information, contact <awa@wetlandcare.com.au>.

Plant conservation through the protection of wetlands

In the past 12 months WetlandCare Australia has actively worked to protect wetland flora and fauna by:

- restoring more than 400 ha, and improving management of more than 1100 ha, of fresh and estuarine wetlands across the Burdekin and Mary River regions of the Great Barrier Reef catchment
- rehabilitating and improving the management of more than 2000 ha of natural fresh and estuarine wetlands throughout the east coast
- planting more than 1000 trees to reinstate valuable wetland and riparian habitat
- erecting more than 40 km of fencing to protect vital wetland and riverine habitats
- supported farmers to adopt innovative wet pasture and strategic grazing regimes that allow native wetland species to co-exist with floodplain grazing.

WetlandCare Australia is committed to plant conservation and protecting Australia's biodiversity. We encourage you to use the resources we are providing as a not-for-profit organisation to help you with your work in plant conservation, research and sharing of your achievements. WetlandCare Australia also has a range of expert staff who are available to assist you on a range of wetland plant issues, including plant identification, management and protection.

If you would like more information on our organisation please contact us on (02) 6681 6169 or email <ballina@wetlandcare.com.au>.

A new organisation supporting wetland restoration, management and research in the Murray Darling

Roger Good

1178 Bungendore Road, Bungendore, NSW. Email: rgo03227@bigpond.net.au

Murray Darling Wetlands Ltd was established in 2009 as an initiative of the New South Wales (NSW) Murray Wetlands Working Group. The company is a not-for-profit organization registered under the Australian Securities Commission as a charity, and has an objective of involving the community in wetland restoration and management.

The company has a Board of Directors and members from the wider community, including scientists, landholders, and conservationists as well as NSW catchment management authorities (CMAs), the NSW Department of Environment, Climate Change and Water, the Murray Darling Association and the Murray-Darling Freshwater Research Centre. The Board and membership include many leaders in wetland management, restoration and research and people who are attuned to modern irrigation practice that takes account of environmental issues.

As a non-profit company Murray Darling Wetlands Ltd seeks corporate and public donations as well as donations of water for wetland restoration and other environmental uses. The Company has 'deductible gift recipient status' with the Federal Government and is listed on the Register of Environmental Organisations.

Murray Darling Wetlands Ltd is committed to building community support for wetland restoration, management and research, by linking corporate donations, management expertise and community participation in restoration

Murray Darling Wetlands community members inspecting a wetland project site. Photo: Roger Good.

projects. It has established a public fund for the specific purpose of supporting all Murray Darling Wetlands Ltd environmental objectives, and will derive income through public donations, water trading and fees for advisory and management services.

Murray Darling Wetlands Ltd is able to:

- engage the community in wetland management projects
- develop partnerships with stakeholders to restore and improve wetland management
- attract corporate and philanthropic support for wetland restoration and management orientated research projects
- develop cooperative wetland management arrangements between catchment management authorities and across state boundaries and agencies
- be a service provider with respect to wetlands, for industry, CMAs and government agencies
- facilitate community understanding and involvement in wetland restoration and management
- provide expert advice and wetland project coordination and management
- develop and implement environmental water monitoring
- initiate and/or support management orientated wetland research projects.

Murray Darling Wetlands Ltd has personnel with experience and expertise in wetland restoration and management. Examples include Moira Lake and Thegoa Lagoon restoration; delivery of 75 000 megalitres of water to more than 200 wetlands across two catchments; wetland mapping and inventory; database development and management; wetland research and monitoring; and project financial management.

For further information contact:

Dr Deb Nias,
Chief Executive Officer,
Murray Darling Wetlands Ltd,
PO Box 313, Blackwood, SA 5051.
Ph: 0417 287 651

Howard Jones,
Chairperson,
Murray Darling Wetlands Ltd,
Block 246, Dareton, NSW 2717.
Mob: 0427 274 525

Roger Good
ANPC member and
Murray Darling Wetlands Ltd Board Member,
1178 Bungendore Road,
Bungendore, NSW 2621.
Ph: 02 6236 9048

Medicinal plants of Nigeria's savannah areas under threat

T.R. Fasola

Department of Botany and Microbiology, University of Ibadan, Nigeria. Email: fasolatr@yahoo.com

The savannah areas of northern Nigeria almost taken over by desertification caused by inadequate rainfall, excessive heat, drought and sand dunes are fast losing plant species. Plants under threat may be rated as critically endangered, endangered, threatened or vulnerable depending on the area occupied, population size and rate of population decline (IUCN, 1994). Human existence is gradually being adversely affected since many plant species found in this harsh region are important for their competing uses for food, medicine and other purposes. Table 1 shows a list of 35 plant species belonging to 17 different families with various medicinal uses. Massive dependence on medicinal plants, destructive and over-collection of barks and other plant parts have given rise to dying and dead trees in this region. As the harvested plant parts become more and more difficult to source from the wild, their market prices correspondingly become higher.

The management and conservation measures in the past had always been influenced by taboos that restricted people from destructive harvesting of plant species (Osemeobo, 1994). The impact of some management actions now may be very small since such services are weak and ill equipped. The medicinal uses of these plant species are vast and alternative lesser known species should be substituted so as to reduce the pressure on the over-sourced ones. As a management strategy, proper records of plant status must be kept so as to monitor the rate and mode of collection for ascertaining how plant species are harvested. The perception and orientation of harvesters must also be changed for they believe that plants can never be exhausted.

Table 1. Medicinal plants of savannah areas of Nigeria showing degree of threat

Botanical name	Family	Part used	Medicinal uses	Degree of threat*
Acacia ataxacantha	Leguminosae	Root	Heart problems	Threatened
Adansonia digitata	Bombacaceae	Stem bark	Heart problems	Threatened
Afzelia africana	Leguminosae	Stem bark	Hernia	Vulnerable
Annona senegalensis	Annonaceae	Root	Gastro-intestinal problems	Vulnerable
Aristolochia ringens	Aristolochiaceae	Root	Gastro-intestinal problems	Endangered
Balanites aegyptica	Simaroubaceae	Stem bark	Central nervous system	Threatened
Bombax costatum	Bombacaceae	Stem bark	Diuretic	Endangered
Bridelia scleroneura	Euphorbiaceae	Stem bark	Rheumatism	Endangered
Cassia arereh	Leguminosae	Stem bark	Dermatitis	Critically endangered
Cissampelos owariensis	Menispermaceae	Root	Rheumatism	Threatened
Combretum collinum	Combretaceae	Leaves	Bronchitis	Critically endangered
Commiphora kerstingii	Burseraceae	Stem bark	Bronchitis	Endangered
Dombeya quinqueseta	Sterculiaceae	Bark	Antidote for snake bite	Endangered
Ficus ingens	Moraceae	Stem bark	Diuretic	Endangered
Ficus thonningii	Moraceae	Aerial root	Jaundice	Vulnerable
Haematostaphis barteri	Anacardiaceae	Stem bark	Febrifuge	Endangered
Hannoa undulata	Simaroubaceae	Bark	Fever	Endangered
Harrisonia abyssinica	Simaroubaceae	Root	Rubefacient	Endangered
Heeria insignis	Anacardiaceae	Leaves	Vermifuge	Endangered
Kigelia africana	Bignoniaceae	Stem bark	Respiratory problems	Threatened
Maprounea africana	Euphorbiaceae	Stem & Root bark	Female fertility problems	Endangered
Ormocarpum pubescens	Leguminosae	Leaves	Rheumatism	Endangered
Parkia biglobosa	Leguminosae	Stem bark	Sore throat	Vulnerable
Prosopis africana	Leguminosae	Stem bark	Pile	Threatened
Pteleopsis suberosa	Combretaceae	Bark	Pile	Endangered
Pterocarpus lucens	Leguminosae	Stem bark	Stomachic	Endangered
Sclerocarya birrea	Anacardiaceae	Bark	Stomachic & wound dressing	Endangered
Securidaca longepedunculata	Polygalaceae	Root	Central nervous system	Vulnerable
Spondias mombin	Annonaceae	Root	Application on wounds & sprains	Vulnerable
Swartzia madagascariens	Leguminosae	Seed	Laxative & diuretic	Endangered
Syzygium guineense	Myrtaceae	Root	Rheumatism	Threatened
Tamarindus indica	Leguminosae	Root & Stem bark	Central nervous system	Vulnerable
Vitex doniana	Verbenaceae	Stem bark	Pile	Threatened
Xylopia aethiopica	Annonaceae	Fruit	Central nervous system	Threatened
Zanha golungensis	Sapindaceae	Bark	Malaria, anelgesic	Endangered

* Based on IUCN (1994)

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Threatened medicinal plants Xylopia aethiopica *(left) and* Kigelia africana *(right). Photos: Taiye Fasola.*

ANPC in the USA: directions in science and conservation at the Smithsonian Institution

Zoë Smith

Smithsonian Environmental Research Center, Maryland, USA. Email: smithz@si.edu

I am currently a postdoctoral fellow at the Smithsonian Environmental Research Center (SERC), Edgewater, Maryland, USA. This regular report covers some of my experiences in environmental research in the United States and provides recent highlights in science and conservation there. An introduction to this regular report and background on SERC can be found in the *Australasian Plant Conservation* 18(2): 28-9.

Snowmageddon

Some call snowflakes Heaven's kisses, but when they fall in armies and build a two foot wall around your house and barricade you inside for days on end they're no longer such a novelty, especially for the back. Hence the popular saying "free snow – shovel all you like!" While Aussies were sweltering in record heat, America was shivering under a blanket of thick snow. In fact, at one stage all 50 states had snow on the ground. Record snowfalls were recorded all over the country, including a season total of over 60 inches in Washington DC. Power outages were commonplace and the nation's capital was largely shut down for a whole week, leading President Obama to call the blizzard 'Snowmageddon'. People were getting around the city on cross-country skis and racing to buy the last of the toilet paper.

Folks here at SERC have been taking bets on when the largest piles of snow will melt. I made the most of the snow by learning how to 'snowshoe' in the beautiful mountains of New Hampshire. In addition, I thoroughly enjoyed my first White Christmas.

Smithsonian research highlights

Researchers in the Forest Ecology lab at SERC have shown that forest growth rate has increased over a 22-year period. The study involved measurements of tree biomass in 55 temperate forest plots in Maryland in eastern USA. Postdoctoral Fellow Sean McMahon and colleagues discovered that, on average, the forest is growing an additional 2 tons per acre annually. Accelerated tree growth appears to be related to increased levels of atmospheric CO2, higher temperatures and longer growing seasons (see *Proceedings of the National Academy of Sciences* 107(8): 3611-5).

Meanwhile, in the Biogeochemistry lab, Postdoctoral Fellow Adam Langley and colleagues measured soil elevation in a brackish tidal marsh under elevated atmospheric CO_2 and found that increased plant productivity accelerated soil elevation gain by 3.9 mm/yr, which has the potential to counterbalance sea-level rises (see *Proceedings of the National Academy of Sciences* 106(15): 6182-6).

In other climate change news, researchers at Michigan State University have found 17 types of actions that could significantly reduce annual household carbon emissions to generate short-term greenhouse gas reductions, such as improved home insulation and upgrades of heating and cooling equipment and general equipment maintenance. Results of the research show that implementation of the suggested actions in America could save up to 123 million metric tons of carbon per year or 7.4 per cent of US national emissions, highlighting the potential for increased policy attention toward household actions (see *Proceedings of the National Academy of Sciences* 106(44): 18452-6).

A review of 22 years of literature surrounding biodiversity management in the face of climate change provides a consensus of recommendations and outlines future directions. The review shows that recommendations generally include improving regional institutional coordination, expanding spatial and temporal perspective and incorporation of climate change scenarios into all planning and action. However, improved biodiversity management will require more specific and operational management plans, a practical planning process that integrates recommendations into policies and programs and greater effort to incorporate human activities. It also needs to extend management of biodiversity beyond reserves and into human-occupied landscapes (see *Biological Conservation* 142: 14-32).

Preliminary results of my research on the mycorrhizal associations of the *Platanthera* orchids show that the genus associates with diverse soil fungi, including known orchid mycorrhizas, ectomycorrhizas and ascomycete fungi. While the majority of fungal isolates were identified as orchid mycorrhizal fungi in the form genus *Tulasnella,* the broad diversity of fungal associations in *Platanthera* contrasts with most terrestrial orchids which associate with narrow fungal clades. Two hybrid taxa associated with fungi that were also identified in their parent species, although one hybrid also associated with a novel fungus.

Information and links

For further information on research at the Smithsonian Environmental Research Center, visit <www.serc.si.edu> or the new blog, Shorelines <http://sercblog.si.edu/>.

New Key Threatening Processes listed under the EPBC Act

Two key threatening processes (KTPs) have been recently listed by the Federal Environment Minister under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). They are:

- Ecosystem degradation, habitat loss and species decline due to invasion by Gamba Grass and other introduced grasses (listing effective from 16 Sept 2009); and
- Loss and degradation of native plant and animal habitat by invasion of escaped garden plants, including aquatic plants (listing effective from 8 January 2010).

The first of the two KTPs recognises the damage being caused by Gamba Grass (*Andropogon gayanus*), Para Grass (*Urochloa mutica*), Olive Hymenachne (*Hymenachne amplexicaulis*), Mission Grass (*Pennisetum polystachion*) and Annual Mission Grass (*Pennisetum pedicellatum*) to plant and animal species and ecosystems in northern Australia.

The second KTP recognises the adverse impacts on native biodiversity and ecosystems of escaped invasive garden plants in many parts of Australia. The 'escapees' include species such as Bridal Creeper (*Asparagus asparagoides*), Lantana (*Lantana camara*), Blackberry (*Rubus fruticosus* aggregate), willows (*Salix* spp.), Salvinia (*Salvinia molesta*), Athel Pine (*Tamarix aphylla)* and Gorse (*Ulex europaeus*) which are now recognised as weeds of national significance.

Details of why these threatening processes have been listed can be found through <www.environment.gov.au/cgi-bin/sprat/public/publicgetkeythreats.pl>.

Report from New Zealand Plant Conservation Network

Eric Scott

Email: mescott@clear.net.nz

New Website

The new PCN website is now fully functional and has a number of new features. Prominent among these is the online shop for various publications, which has already proved a great success. The site also has new search functions. For example, if any Australian reader coming to New Zealand is planning to visit a reserve or a number of reserves, it is now possible to search online for plant lists for specific areas. This search function has a Google mapping interface. The site now has over 18 000 images loaded and that total is increasing all the time. Offers of images that we could add to that total are always gratefully accepted.

New Zealand's favourite plant

In the 2009 vote for New Zealand's favourite plant the winner was Pingao, Golden Sand Sedge (*Desmoschoenus spiralis*). It won in competition with over 100 species. The top ten included three species on the verge of extinction.

Threatened Plants of New Zealand

This new book by Peter de Lange, Peter Heenan, David Norton, Jeremy Rolfe and John Sawyer, published by Canterbury University Press, was officially launched by the Minister of Conservation, the Hon Kate Wilkinson, on Thursday 25 March. The beautifully illustrated book combines precise botanical description with lavish illustrations in describing the 189 species defined by conservation scientists as Extinct or Threatened, using the New Zealand Threat Classification System. Each description contains information on how to identify the plant in question, the specific threats it faces, and its current distribution.

Research Roundup

Compiled by Kirsten Cowley, Centre for Plant Biodiversity Research, Canberra.

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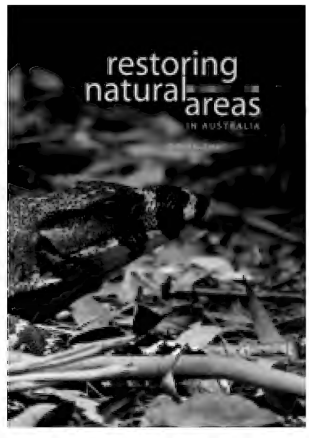
Book Reviews

Restoring natural areas in Australia

by Robin A. Buchanan

Tocal College, Paterson, NSW, 264 pages, lavishly illustrated in colour. ISBN 978-0 7313 0621-3, $44.00 (inc GST), plus postage and handling. Order online at www.dpi.nsw.gov.au/aboutus/resources/bookshop/, or by phone on 1800 025 520



Robin Buchanan's new book *Restoring Natural Areas in Australia* has recently been released, and is sure to fill a gap for anyone with a practical interest in the Australian bush.

It is 20 years since Robin's book *Bush Regeneration–Recovering Australian Landscapes*, was published. It was a milestone for bush regeneration, then a fairly new industry. A weighty and information-packed text book, it complemented the formal qualification (also designed by Robin) offered through the NSW TAFE system, and helped the industry gain credibility and recognition. It became an Australian best seller, but has been out of print for some time.

Knowledge about restoring natural areas has continued to grow and the industry has expanded, and for some years Robin has been keen to up-date the book. The project got underway in earnest in 2006 with the involvement of Tocal College, a NSW government training centre specialising in agriculture and land management, and also a publisher of reference books.

Darren Bayley, Acting Manager of Continuing Education at Tocal, explained that through the National Conservation and Land Management Training Network, he is in regular contact with training providers across the country. He heard a consistent message: we need a basic ecological restoration textbook. With Tocal publishing, and some financial assistance from the Australian Association of Bush Regenerators NSW, *Restoring Natural Areas in Australia* was born.

No longer teaching full time, Robin, and her collegue Ann Loughran, were available and willing to start from scratch to develop a completely new book. The last two years have been full of researching and writing. Robin found that a lot more specific information was available now—such as planting techniques for particular regions, how to control specific weeds, project descriptions and scientific research. She tried to bring all this together, interpret it and make it accessible. However she was concerned that there was not enough information about general principles: how to think through a project, assess a site, and so on, so she set out to fill the gaps.

The new book is very clearly written and is suitable for those who do not have access to a training course and wish to undertake land restoration on their own properties. Other users would be those who work with groups involved in land restoration, as well as students.

Restoring Natural Areas in Australia touches on just about every aspect of the wide-ranging field of land restoration and bush regeneration. The layout is user friendly, with much of the content illustrated by a wonderful selection of photos and diagrams. Tables detailing specific actions for use in restoration provide very clear information.

The book covers the basics of how to understand the ecosystems being restored, and see the wide range of possible actions. Importantly there is advice about where to find out more about these topics.

To succeed in restoring a natural area means 'tuning in' to the landscape, learning to read its health, and estimating the level of resilience—the ability of degraded bushland to naturally regenerate. In the section on 'Setting the Scene', this concept is described as 'the most important concept that you will need to know when restoring an area'. Assessing and harnessing resilience has its own chapter.

The other topics covered include:

- Basic ecology, different ecosystems
- What is ecosystem resilience
- How natural areas become degraded and in need of repair
- Project planning, management, costing, deciding what your priorities should be, what methods to use, monitoring
- Funding, legal issues
- Assessing your site, including soils, geology, landform, vegetation, wildlife, fire, aquatic systems, weeds
- The practicalities of doing the work, including tools, safety, weed management techniques, herbicides, erosion control, seed collecting and planting, pile burns, stormwater management.

One particularly useful section is 'Organising your project—where do you start?'. Advice on how to plan a project, and determine what to do first, is not always easy to find, but *Restoring Natural Areas* helps fill the gap. Under this topic different ways are suggested for managing your project. Costing of a project is covered in another chapter. Planning your project and costings for proposed work are especially relevant when seeking funding and assistance.

The section 'Working on your site' gets down to the nitty gritty of how to manage weeds so that natural regeneration can occur, how to use other restoration methods such as direct seeding, and how to carry out pile burns. A large variety of weed control techniques are illustrated and

Book Reviews (cont.)

details of the methodology given. In addition to the generally used techniques, others are introduced such as solarisation, scalping and capping.

Those interested in the conservation of particular plant species will be able to use this book to understand the restoration of ecosystems and habitat. Information relating to particular plant species and their requirements may need to be sourced elsewhere—especially for threatened species, which should only be worked on in agreement with the local conservation agency.

Restoring Natural Areas in Australia is easy to understand for those who are new to restoration, and will also be a useful refresher for experienced folks who may not have formal training or were trained a few years ago—a chance to catch up with the latest thinking. As an interesting and practical guide to coexisting with our natural environment, it deserves a place on every Australian bookshelf.

Louise Brodie, NSW Department of Environment and Climate Change, Sydney and Virginia Bear, Newsletter Editor, Australian Association of Bush Regenerators NSW.

Australia's Biodiversity and Climate Change

by Will Steffen (lead author)
CSIRO Publishing, Collingwood Vic., 2009,
248 pages, lavishly illustrated including colour photographs.
Paperback, ISBN: 9780643096059, $69.95
Available from: www.publish.csiro.au

Publication of this important book coincided with the failure of the Copenhagen meeting and a plethora of media commentaries either bemoaning or welcoming this outcome. Amid all this excitement, the potential impacts of climate change on biodiversity have tended to be lost from view, other than for a few cause célèbre, such as the polar bear.

Australia is, as federal environment ministers are wont to emphasis, one of the few megadiverse first world nations. Even if our claims over large areas of Antarctica are put aside, Australia includes a vast range of climatic conditions, from tropical to subantarctic, from (limited) areas of high, reliable rainfall to a vast arid zone. The United Nations' Convention on the Law of the Sea gives the Commonwealth responsibilities for managing a huge area of ocean and its biodiversity, but the main focus of this book is on Australia defined by the edge of the continental shelf, although Christmas Island gets a brief mention.

Australia's biodiversity is reviewed in a succinct account, which is a model of its type and, I hope, is destined to become essential background reading for ecology and geography courses. The justification for conserving biodiversity is also presented and there is a clear discussion of what is meant by ecosystem services.

The changes to Australian biodiversity since European settlement are reviewed, and the interactions of various stressors emphasised. These stressors will continue to have impact on biodiversity regardless of climate change, but when climate change is superimposed on the environment, it will exacerbate them. Reponses of human society to the effects of climate change may, unless carefully managed, adversely affect the survival of many components of biodiversity. History makes me pessimistic that we will be able to act in time to prevent many impacts.

Climatic trends, based on a variety of observations, are discussed. One of the postulated drivers for climate change is an increase in atmospheric carbon dioxide concentration, and even the most rabid of climate change deniers would be hard put to dispute that the current CO2 concentration in the atmosphere is far higher than pre-industrial revolution times, nor that the rate of increase is itself increasing. What is less often appreciated is that the change in carbon dioxide levels will have differential direct effects on plant species, resulting in change in community composition, and flow-on effects to fauna.

There have already been changes in species distribution or performance in a variety of environments, which are best interpreted as responses to climate change but these are only the prelude to anticipated extensive changes over the next few decades. Australia is amongst the world leaders in modelling species' distribution and developing predictions of responses to climate change and examples of these are provided.

The idea of communities as 'super organisms' was much debated in the early twentieth century but was rejected in favour of models based on the individuality of species' responses to environmental conditions. Nevertheless some of the popular discussion of responses to climate change envisages not only species but communities moving across landscapes. However, species will move at different rates, so that while we can talk about entities such as 'forest' or 'woodland' moving, it is less likely that 'assemblages of species' (the definition of community within threatened species legislation) will remain intact. There will be

Book Reviews (cont.)

'novel' combinations of species, not just of native but also introduced species. Predicting what these combinations will be is very difficult; we must expect the unexpected.

The challenges of conservation in a changing and uncertain world are discussed and suggestions for policy responses are offered.

One of the most important features of the biodiversity paradigm is that it has broadened the objects of conservation. While a great deal of biodiversity conservation has focussed attention on only a small proportion of biodiversity-threatened (in the formal sense defined by legislation) species, it has also been possible to designate threatened communities. While this had been important in broadening public understanding of the scope of conservation, it presents great challenges for the future.

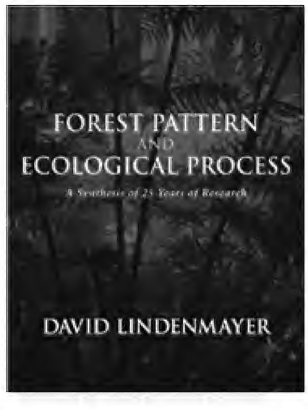
Under the new environmental regime there will be winners and losers amongst species. I suspect that few of the currently listed threatened species will be winners but it is difficult to predict which species will fall in which category. How do we allocate our conservation dollar for best long term return? Even if we maximise connectivity in the landscape should we be more interventionist and 'help' species island-hop or move through corridors? Should we focus on conserving specific communities, even though their species composition may change, or should we concentrate primarily on strategically enhancing connectivity across the country?

These debates will necessarily continue, but Steffen *et al.* have provided a firm foundation on which to base the discussion.

Associate Professor Paul Adam, School of Biological Earth and Environmental Sciences, University of New South Wales.

Forest Pattern and Ecological Process
A synthesis of 25 years of research

by David Lindenmayer
CSIRO Publishing, Collingwood, Vic., October 2009, 320 pages, illustrations (including colour).
Paperback, ISBN: 9780643096608, $120.
Available from: www.publish.csiro.au



Seldom has there been the continuity of research over several decades in one ecosystem as detailed in this book by David Lindenmayer and his co-research personnel in their study of the montane ash forests of the Central Highlands of Victoria.

Forest Pattern and Ecological Process is a synthesis of more than 25 years of ecological research in the ash forests. Most significantly, it provides the reader with an understanding of the role and function of the many components that make up the ash forest ecosystem and the many issues involved in carrying out research in forests such that the many ecological links between the biota and the landscape can be recognised.

The book does not present any new research but it does provide, through easily read text, a clear and concise synthesis and understanding of the research carried out by Lindenmayer and his team. As he states in the preface, 'the book has been written for a broad audience, including other researchers, resource managers, policy-makers, naturalists and readers with a general interest in forests'.

The structure of the book readily meets Lindenmayer's expectations for a wide readership. It has seven parts in 18 chapters, five parts being on the core components of forest cover and composition, structure of the ash forests, native animal occurrence and distribution, disturbance regimes, and forest management and biodiversity conservation. Each individual part finishes with a summary of the topics covered in that part, a short statement of the lessons learned, the remaining knowledge gaps and the links of each topic to other parts preceding it.

Having read through parts 1 to 6, one gains a clear understanding of the forest environment within which Lindenmayer and his team carried out the many research projects that are well synthesised in the book. The Central Highlands montane forests are seen in quite a different perspective and one certainly gains a 'feel' for the dynamic nature of these special forest ecosystems.

The chapters on disturbance regimes (Part 5) examine three broad examples of disturbance: a natural disturbance (fire) and two imposed disturbance regimes (clearfell logging, and post-fire or salvage logging). The impacts of disturbance and the role disturbance plays in the vegetation dynamics and the distribution of flora and fauna species, are clearly articulated in these chapters.

The structure of the chapters and the text within each provides for continuity of the themes and topics outlined, and engenders in the reader a need and desire to continually reconsider the previous topics in terms of each subsequent chapter. All readers will be inspired by this book to delve further into the detail of the non-tree components of the montane ash forests. The book could well be titled 'Seeing the forest beyond the trees'.

Book Reviews (cont.)

The book should be read by all ecology students even if they are not studying montane forest ecology, as throughout the chapters, Lindenmayer explains the many issues in establishing and undertaking ecological research in montane forest systems, as well as providing suggestions and guidelines to address these in other forest and non-forest environments.

A short but significant chapter is Chapter 17, which addresses the perennial issue of monitoring. As Lindenmayer notes, there is a prolonged history of poorly planned and unfocused monitoring programs that are either ineffective or fail completely, and very few examples of long-term monitoring programs that contribute to effective and meaningful natural resource management.

The monitoring program in the Central Highlands montane ash forests is a stand-out example of what is required of monitoring especially over a long time-frame. This has provided Lindenmayer with the experience and expertise to detail the issues to be addressed in setting up an effective long-term ecological monitoring program, particularly one that contributes to future ecosystem and biodiversity conservation and management. If students read no more than this chapter, they will have gained much from this book.

The 2009 fires in the Central Highlands montane forests have provided Lindenmayer and his team new directions in forest research which he acknowledges will take another 25 years to address. One can only hope that his research team will be provided with the resources to continue over that period and that they will synthesise the work in the same ways as have been covered in this book.

Written by a very hands-on and noted ecologist, *Forest Pattern and Ecological Process* is arguably one of the best contributions to ecological understanding written in Australia in recent years. It should be on the shelf of every ecology and natural resource management student, as well as in the library of every higher education institution where ecology and natural resource management courses are presented.

As Lindenmayer admits, the book has not been easy to write and there are many omissions of topics that he would have liked to, or should have, included within it. Irrespective, he has done a superb job of synthesising 25 years of research into very easily read and understood text, from which students of ecology, biodiversity management, natural resource management and the like, will benefit. Unfortunately the cost of the book will be beyond the financial resources of many University students, making access to it through libraries even more essential.

Roger Good, Alpine Ecologist, Bungendore, NSW.

Information Resources and Useful Websites

Planting Wetlands and Dams: A Practical Guide to Wetland Design, Construction and Propagation (2nd edition)

Nick Romanowski
Landlinks Press, November 2009, 169 pages
Paperback ISBN: 9780643096363, AU$59.95

Planting Wetlands and Dams is a step-by-step, plain language guide to the creation of conditions in which wetland plants will thrive, from design and construction to collecting plants, seeds and propagation. Completely revised and expanded, this new edition includes comprehensive information for around 200 genera of wetland plants from Tasmania to the tropics, complemented by more than 60 new colour photographs. It discusses the modification and improvement of existing dams, new lining materials available, and planning for plant and animal habitat needs. It provides updated information on legal requirements as well as significant exotic weeds, and examines the pros and cons of establishing new wetlands in dry climates. The book is available from <www.publish.csiro.au/nid/20/pid/6162.htm >.

Contested Country: Local and Regional Natural Resources Management in Australia

Marcus B. Lane, Cathy Robinson & Bruce Taylor (eds)
CSIRO Publishing, October 2009, 264 pages
Paperback ISBN: 9780643095861, AU $79.95

In this book leading researchers in planning, geography, environmental studies and public policy critically review Australia's environmental management under the auspices of the Natural Heritage Trust over the past decade, and identify the challenges that must be met in the national quest for sustainability. It is the first comprehensive, critical examination of the local and regional natural resources management undertaken in Australia, using research sourced from all states as well as the Northern Territory. The book challenges some of the accepted benefits, assumptions and ideologies underpinning regional scaled environmental management, and is available from <www.publish.csiro.au/nid/20/pid/6002.htm>.

Information Resources and Useful Websites (cont.)

Numbers of Living Species in Australia and the World (2nd edition)

A.D. Chapman
Australian Biological Resources Study, Canberra, September 2009, 80 pages
ISBN (printed) 978 0 642 56860 1
ISBN (online) 978 0 642 56861 8

This report updates information first published in 2006, drawing on the most up-to-date data. It estimates that Australia has 21 171 vascular plant species (including ferns and bryophytes, and 1184 new records or newly described species) and 11 846 species of fungi. Of the vascular plants, it notes that 92 per cent are endemic to Australia, and 6.5 per cent are under threat. Copies of the report can be downloaded from <www.environment.gov.au/biodiversity/abrs/publications/other/species-numbers/index.html>.

Australian native grasses: A manual for sowing, growing and using them (3rd edition)

I.H. Chivers & K.A. Raulings
Native Seeds Pty Ltd, November 2009, 60 full colour pages
ISBN 9780646516332 (pbk), AU$19.95

This book contains detailed information on 16 Australian native grasses, both warm and cool season, and includes information on a range of applications for their use. Each page has full colour photographs to assist in their identification. There is also information on seedling identification, seed storage and provenance.

The book is available from <www.nativeseeds.com.au/categories.asp?cID=92&c=15403>.

Noxious and environmental weed control handbook (4th edition)

Rod Ensbey
Industry & Investment NSW, 2009, 84 pages
ISSN 1443–0622

This handbook provides a guide to weed control in non-crop, aquatic and bushland situations in New South Wales. It lists weeds that have been declared as noxious weeds in that state, and includes material on integrated weed management, noxious and environmental weed control, and permits and legal responsibilities as well as information on actual control methods. Copies of the book are available from Industry and Investment NSW (formally the Department of Primary Industries) offices, or can be downloaded from <www.dpi.nsw.gov.au/__data/assets/pdf_file/0017/123317/noxious-and-environmental-weed-control-handbook.pdf>.

Grassland Flora, a Field Guide for the Southern Tablelands (NSW and ACT)

David Eddy, Dave Mallinson, Rainer Rehwinkel and Sarah Sharp
Environment ACT, 1998, 156 pages
ISBN: 0731360214, AU$20 plus postage, discount available for multiple copies

This easy to use field guide helps people to explore grassland plants in grassland heritage areas on the Southern Tablelands of New South Wales and the Australian Capital Territory. The book is now distributed by Friends of Grasslands Inc., and can be ordered via its website <www.fog.org.au> or by contacting Sarah Sharp on 0402 576 412 or at <booksales@fog.org.au>. The discount price for 35 or more copies is $12 per copy plus postage.

Grassy Ecosystems Management Kit: a guide to developing conservation management plans

Sarah Sharp, Josh Dorrough, Rainer Rehwinkel, David Eddy and Ann Breckwoldt
Environment ACT, 2005, loose-leaf folder
ISBN: 0642603405; hard copy: AU$30.00 plus postage, discount for multiple copies; CD: AU$7.00 including postage

The kit contains step-by-step activities that are used to develop a conservation management plan for your site. Learn how to assess what you have on site, identify achievable management aims, prepare a site work program and assess whether your management actions are achieving your desired results. The guide is now distributed by Friends of Grasslands Inc., and can be ordered via its website <www.fog.org.au> or by contacting Sarah Sharp on 0402 576 412 or at <booksales@fog.org.au>. The discount price for 10 or more copies of the hard-copy kit is $20 per copy plus postage.

Taxonomy Research & Information Network (TRIN)

http://www.taxonomy.org.au/index.html

Taxonomy, which is the science of the discovery, description, identification and classification of organisms, provides the basis for identifying and monitoring Australia's biodiversity which in turn provides the knowledge needed for effective environmental management.

TRIN is helping to address critical gaps in taxonomic knowledge of key Australian animal and plant groups. More details about projects relating to plants, including Environmental Weeds and Australian Mangrove and Saltmarsh Species, can be found on the website. There is also a TRIN Wiki which features collaborative web spaces. Member details can be found on the wiki and anyone who wishes to join and contribute is welcome.

Conferences and Workshops

Knowledge for managing Australian landscapes—the legacy of Land & Water Australia conference

18-19 May 2010
Shine Dome, Canberra

This two-day conference, being convened by the Australian River Restoration Centre (ARRC) will reflect on the legacy of Land & Water Australia research from 1990 to 2009. Lessons from the 20 years of applied research and development will be distilled and presented in a series of forward-looking analyses. These analyses will discuss the types of knowledge that will be needed over the next 20 years for 'successful' natural resources management, and consider how such knowledge might best be acquired, used and managed.

Further information:
http://australianriverrestorationcentre.com.au/

2010 CERF Conference

24-26 May, 2010
Old Parliament House, Canberra, ACT

The Commonwealth Environment Research Facilities (CERF) program has directed funding to research with a strong 'public good' focus and outcomes. Priority research areas have including work related to the condition of Australia's environmental assets, threats and risks to the Australian environment, and pressures on the coastal environment. The Taxonomy Research & Information Network (TRIN; see page 35 of this issue) is one of the CERF research hubs. The 2010 CERF Conference—*What have we learnt, the first four years of the Australian Government's Environmental Research Program*—will feature presentations from Australia's leading environmental researchers as well as up and coming 'research stars'.

Further information: contact
adam.cowell@environment.gov.au

Postgraduate Workshop in Pollination Ecology

17-20 October 2010
Mt Hyland Wilderness Retreat, northern NSW

This hands-on workshop is being organised for students studying pollination ecology. Activities include demonstrations and discussions on methods in determining breeding systems, pollen flow, pollen libraries, pollen-tube growth, pollen germination, insect identification, pollinator networks, molecular tools, working with endangered species, non-invasive pollen sampling from mammals and insects and opportunities for student presentations. Costs: $950 for 3 nights, 4 days and includes accommodation, meals and course materials. Return transport from Armidale to the Retreat is available for $50 but seats are limited.

Further information and to pre-register interest for the workshop: contact Caroline Gross via the on-line site <https://www.surveymonkey.com/s/JWTYNXT>

Ecological Society of Australia Annual Conference Sustaining biodiversity—the next 50 years

6-10 December 2010
Canberra, ACT

The conference will celebrate the 50th anniversary of the Society, during the International Year of Biodiversity. A series of themes will focus on the challenges that will be faced by Australian ecosystems over the next 50 years, and the way that our science will need to adapt to meet these challenges. The conference will take a long-term perspective of ecology in Australia and engender a sense of urgency to consider how ecologists can provide solutions to those problems with which we are now familiar, and those on the horizon.

Further information: www.esa2010.org.au

XVIII International Botanical Congress

23-30 July 2011
Melbourne, Vic.

Congress themes include: Systematics, evolution, biogeography and biodiversity informatics; Ecology, environmental change & conservation; Structure, development & cellular biology; Genetics, genomics & bio-informatics; Physiology & biochemistry; and Economic botany including biotechnology, agriculture & plant breeding. Keynote symposia under consideration include topics such as Climate change and adaptation; Evolutionary biology of land plants; Food production: challenges and solutions; Origins of Australian and southern flora; Plant biotic interactions (including plant–insect–fungi); Plant diversity and ecology; and Plant systematics in the 21st Century.

Further information: http://www.ibc2011.com/Program.htm

ANPC Corporate Members

ANPC acknowledges the support of the following corporate members

Albury Botanic Gardens, NSW

Australian National Botanic Gardens, ACT

Botanic Gardens of Adelaide, SA

Botanic Gardens Trust, NSW

Centre for Plant Biodiversity Research

Department of Environment and Conservation, WA

Dept of Sustainability and Environment, VIC

ForestrySA

Greening Australia, VIC

Mackay Regional Botanic Gardens, QLD

Redland City Council, QLD

Royal Botanic Gardens Melbourne, VIC

Royal Tasmanian Botanical Gardens, TAS

Sydney Olympic Park Authority, NSW

University of Melbourne, Burnley Campus, VIC

Australian Network for Plant Conservation Inc (ANPC)

8TH NATIONAL CONFERENCE

Planning conservation to achieving restoration:

A conference for everyone involved in conserving Australia's unique flora and native vegetation

28 September to 1 October 2010, Perth WA

Early bird registration open until 28 July 2010
Call for abstracts open until 16 July 2010

Conference themes:

CONSERVATION PLANNING

Strategic conservation planning projects are underway all around the world in an attempt to make the most of limited resources to get the best conservation outcomes possible. This theme will explore some of these efforts and their significance to plant conservation. Will landscape or regional-scale planning save individual species?

SEEDS AND GENES FOR RESTORATION

Successful ecological restoration necessitates the collection of high quality and suitably sourced seed. This raises a number of issues related to genetic provenance, seed quality and harvest sustainability. Although restoration guidelines generally recommend using local seed sources to maximise local adaptation and prevent outbreeding depression this approach may not be ideal in highly modified landscapes and under scenarios of rapid climate change. In this theme we will investigate the trade-off between the need for local sourcing and broader sourcing of seed, keeping in mind that restored plant populations will need to be functional, self-sustaining and resilient to environmental challenges.

ENGAGING WITH INDUSTRY

Engaging with industry can provide opportunities to utilise specialist expertise and experience in conservation and restoration projects, and form valuable partnerships which can achieve successful outcomes. Whether it's botanical consultants identifying conservation values through survey work or mining companies managing restored land on their leases, there are many avenues to engage industry. This topic seeks to discuss the challenges of identifying the 'who, what, how, why and when' of industry involvement in plant conservation.

THE ROLE OF TAXONOMY

Taxonomy is the science of discovering, resolving, describing, naming and identifying living organisms. It provides the key building blocks for biological science and conservation and the most fundamental audit and inventory of biodiversity. Without the basic knowledge of species of plants, fungi and animals provided by taxonomists, managing and interacting with the natural world would be an impossible task. This theme explores taxonomy as a critical underpinning science in conservation planning, sustainable development, biodiversity research, natural resource management and community engagement with the living world.

SOIL HEALTH AND RESTORATION

The composition of vegetation, and presence of particular species of plants, is driven to a great extent by the soil upon which they occur. Disturbance can alter soil structure and chemistry such that restoration projects may need to either undertake soil-restoration works, or look outside of original vegetation composition to restore ecological function. This theme looks at how projects can and do deal with soil health in effective restoration projects.

PLANNING FOR CLIMATE CHANGE

Human-caused climate change is already having a profound impact on plant conservation. In this theme we explore: adaptation and transformation, including the importance of refugia in conservation programs; managing new vulnerabilities, compounded by the effects of the disturbance; and, translocation, restoration and the implications for landscape ecology.

Futher information can be found on the ANPC website:
www.anpc.asn.au/conferences/2010/


Banksia prionotes. Photo: David Eagles


Calytrix brevisета. Photo: Andrew Crawford


Photo: Melanie Smith


Verticordia albida. Photo: Andrew Crawford


Banksia nutans. Photo: Greg Guilfoyle


Jacksonia purgens. Photo: Andrew Crawford

Australasian Plant Conservation
BULLETIN OF THE AUSTRALIAN NETWORK FOR PLANT CONSERVATION INC

For further information contact:
Australian Network for Plant Conservation
GPO Box 1777
Canberra ACT 2601, Australia

Ph: + 61 2 6250 9509
Fax: + 61 2 6250 9528
Email: anpc@anpc.asn.au
Website: http://www.anpc.asn.au